16-40182/1016-6

TM 11-4051

WAR DEPARTMENT TECHNICAL MANUAL

RECORDER

BC-1016

REPAIR INSTRUCTIONS

WARNING: The material forming the subject matter of this manual is the property of the United States Government and it is printed and distributed solely for the use of the military, naval, and civilian personnel of the War and Navy Departments, and may not be published or reproduced in whole or in part in any manner or form (except by lawful copyright holders who may reproduce their copyrighted material in its original form) except upon specific approval by authorized military public relations agencies.

WAR DEPARTMENT • JANUARY 1946

WAR DEPARTMENT TECHNICAL MANUAL

TM 11-4051

RECORDER

BC-1016

REPAIR INSTRUCTIONS

WAR DEPARTMENT • *JANUARY 1946*

WARNING: The material forming the subject matter of this manual is the property of the United States Government and it is printed and distributed solely for the use of the military, naval, and civilian personnel of the War and Navy Departments, and may not be published or reproduced in whole or in part in any manner or form (except by lawful copyright holders who may reproduce their copyrighted material in its original form) except upon specific approval by authorized military public relations agencies.

United States Government Printing Office
Washington: 1946

WAR DEPARTMENT
WASHINGTON 25, D. C., 4 January 1946

TM 11–4051, Recorder BC–1016, Repair Instructions, is published for the information and guidance of all concerned.

[AG 300.7 (5 Oct 45)]

BY ORDER OF THE SECRETARY OF WAR:

OFFICIAL:
EDWARD F. WITSELL
Major General
Acting The Adjutant General

DWIGHT D. EISENHOWER
Chief of Staff

DISTRIBUTION:
AAF (5); AGF (5); ASF (2); T of Opns (5); Dept (2); Base Comd (2); Island Comd (2); Arm & Sv Bd (1); S Div ASF (1); Tech Sv (2); SvC (2); Air Tech SvC (2); Dep 11 (2); Lab 11 (2); 4th Ech Maint Shops 11 (2); 5th Ech Maint Shops 11 (2); T/O & E 11–107 (3); 11–127 (3); 11–587 (3); 11–592 (3); 11–597 (3).
Refer to FM 21–6 for explanation of distribution formula.

CONTENTS

		Paragraph	Page
SECTION I.	DESCRIPTION OF RECORDER BC–1016.		
	General	1	1
	Over-all system function	2	1
	Condensed circuit analysis	3	2
II.	DIFFERENCE BETWEEN MODELS.		
	Operational differences	4	4
	Design differences	5	4
III.	INITIAL REPAIR PROCEDURES.		
	General	6	5
	Special test, tool, and cleaning equipment for Recorder BC–1016	7	5
	Removal of tubes	8	7
	Removal of inker assembly	9	8
	Removal of motor drive assembly	10	10
	Cleaning, inspection, and lubricating of chassis	11	10
	Cleaning, inspecting, and testing of tubes	12	11
	Cleaning, inspecting, testing, and lubricating of inker assembly	13	11
	Cleaning, inspecting, testing, and lubricating of motor drive assembly	14	14
IV.	PRELIMINARY TROUBLE-SHOOTING PROCEDURES.		
	Input resistance measurements	15	18
	Operating test	16	19
V.	ALIGNMENT PROCEDURE.		
	Alignment	17	21
VI.	DETAILED TROUBLE-SHOOTING PROCEDURES.		
	Signal tracing	18	22
	Voltage and resistance measurements	19	24
	Moistureproofing, fungiproofing, and refinishing	20	24
VII.	FINAL TESTING.		
	General	21	25
	Sensitivity	22	25
	Frequency response test	23	25
	Speed indicator dial calibration	24	25
	Drive tension adjustment	25	25
	Operational test	26	26
VIII.	INDIVIDUAL STAGE AND CIRCUIT REPAIR DATA.		
	Power Supply No. 1	27	29
	Power Supply No. 2	28	31
	Amplifier-limiter stage	29	33
	Signal-rectifier stage	30	35
	Trigger stage	31	37
	Bridge stage	32	40
	Pen-amplifying stage	33	42
	Inker assembly	34	44
	Motor drive assembly	35	48
IX.	SUPPLEMENTARY DATA.		
	Unclassified parts	36	51

WARNING

HIGH VOLTAGE

is used in the operation of this equipment.

DEATH ON CONTACT

may result if safety precautions are not observed

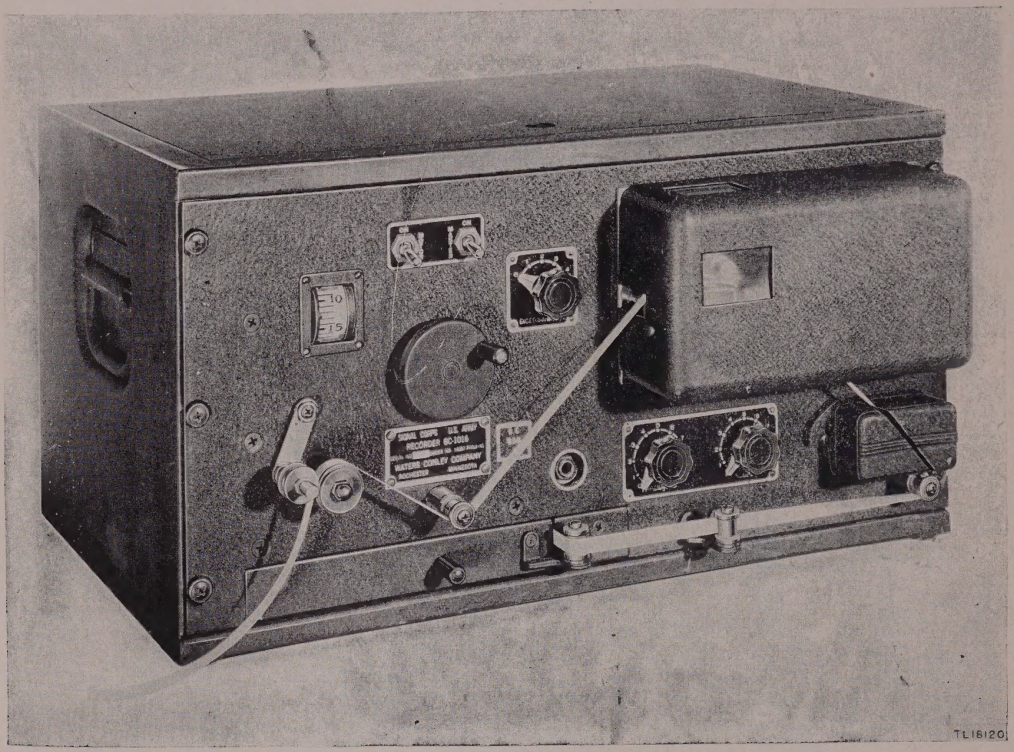


Figure 1. Recorder BC–1016

SECTION I

DESCRIPTION OF RECORDER BC–1016[1]

1. General

a. GENERAL. Recorder BC–1016 (fig. 1) is designed for ink recording of code signals at speeds up to 400 words per minute on ⅜-inch paper tape for visual reading. The input of the recorder may be connected to a telephone line transmitting radio signals, to the output circuit of a radio receiver, or directly to the output terminals of a hand keyer or several types of automatic keyers. The recorder is a self-contained unit and for operation requires only connection to an alternating-current (a-c) power supply line and a signal source. General tactical use of the equipment is for the permanent recording of decipherable or undecipherable code signals. In the case of unknown codes, the paper tape gives a record of the dots and dashes of the signal which may be decoded at any time. The equipment may also be used for direct keying by an operator using either a semiautomatic or hand key.

b. POWER SUPPLY. The equipment operates on conventional 117-volt a-c power line, 50–60 cycles, or on 170, 210, or 240 a-c voltages. Switch 188 must be set to the required voltage position as marked on the switch.

c. POWER INPUT.

6.3 a-c volts filament and panel lamps at 4.0 amperes.
5.0 a-c volts filament (tube 221–1) at 3.0 amperes.
5.0 a-c volts filament (tube 221–2) at 3.0 amperes.
280 d-c volts B+ Power Supply No. 1 at 50 milliamperes.
280 d-c volts B+ Power Supply No. 2 at 90 milliamperes.
Total power consumption..... 140 watts
Stand-by power consumption 85 watts

d. INPUT SIGNAL. The input signal required for operating the recorder is a keyed tone signal with a voltage between 0.75 and 50 volts and a frequency between 500 and 5000 cycles per second. Normal input operating voltage is from 2 to 5 volts. The input impedance is 5000 ohms at 1000 cycles, measured across the outside input terminals (fig. 40); from center terminal to one outside terminal input impedance measures 1250 ohms at 1000 cycles.

e. MOUNTING. Recorder is supplied mounted in a cabinet. However, the recorder chassis fits a standard 19-inch relay rack and may be so mounted by removing the chassis from the cabinet. Weight with cabinet is 80 pounds. The equipment is designed for stationary operation.

f. SUPPLEMENTARY EQUIPMENT. (1) Paper recorder tape ⅜-inch wide.

(2) Recorder ink of appropriate type.

(3) Electronic motor control (not supplied with equipment).

(4) Monitoring headphones (not supplied with equipment).

(5) Fuses and pen reamers in tape drawer.

2. Over-all System Function

The circuit of Recorder BC–1016 is designed only for audio signals (500 to 5000 cycles per second). Input signal should be in the form of keyed audio signals from a radio receiver, a telephone line, automatic keyer, hand keyer, or a keyed oscillator. The recorder changes the alternating current audio signals to direct current pulses in the form of a square wave. After amplification, this waveform is transcribed by a pen onto a moving paper tape.

[1] Refer to TM 11–441, for installation, operation, and other maintenance data on this equipment.

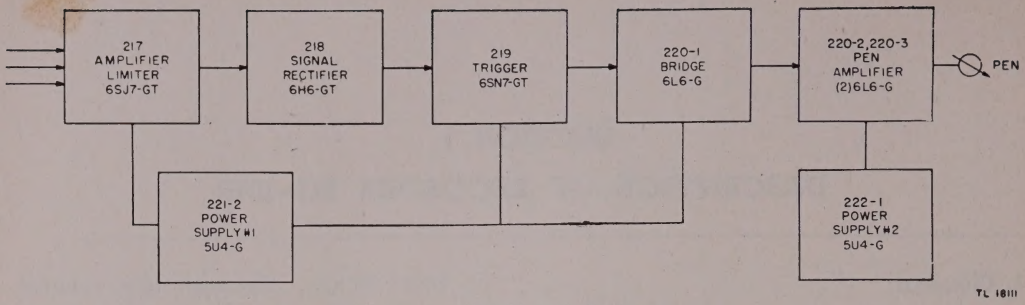


Figure 2. Simplified block diagram.

3. Condensed Circuit Analysis

a. The following eight tubes are, used, stage by stage:

Function	Reference number	VT No.	JAN
Amplifier-limiter stage	1 tube (217)	VT-116-A	6SJ7-GT
Signal-rectifier stage	1 tube (218)	VT-90-A	6H6-GT
Trigger stage	1 tube (219)	VT-231	6SN7-GT
Bridge stage	1 tube (220-1)	VT-115-A	6L6-G
Pen-amplifying stage	2 tubes (220-2) and (220-3)	VT-115-A	6L6-G
Power supply No. 1	1 tube (221-2)	VT-244	5U4-G
Power supply No. 2	1 tube (221-1)	VT-244	5U4-G

b. The incoming signal is passed through an input transformer (178) to an amplifier-limiter tube (217) which raises the level of weak signals but limits the level of strong input signals. In this manner the output of the amplifier limiter is substantially constant at a certain determined level controlled by the setting of THRESHOLD control (206).

c. The output of the amplifier limiter is still an audio signal. It is fed into the full wave, signal-rectifier tube (218) through coupling transformer (177) where it is rectified. The signal is filtered by choke (181) and capacitor (216) so that the output from the signal rectifier is essentially a key direct voltage, being zero during the space time and a definite value during the mark time.

d. The signal-rectifier stage feeds the signal into the trigger tube (219). The function of this tube and circuit is to give an output voltage of either of two values, a certain definite positive value during the space time of the signal, and a lower positive value during the mark time. The transition between these values is rapid, so the output signal of this circuit shows as a square waveform as shown in figure 3.

e. The signal is fed from the trigger stage into a bridge circuit (tube 220–1) with which a push-pull amplifier is associated. The push-pull circuit is built around tubes 220–2 and 220–3. These two circuits in combination translate the low-power output of the trigger circuit into signals strong enough to operate the pen-drive electromagnets (20), placing the pen in one position during space time and in another position during mark time. The waveform made by the pen is recorded on the moving tape that is drawn by the motor-powered tape drive roller (96) through the inker assembly.

(1) The SLOPE control (207) functions to adjust the minimum bias voltage on the grids of pen-amplifier tubes (220–2) and (220–3), controlling the amount of power the pen-drive unit receives. The rate of travel of the pen across the surface of the tape is determined by the amount of power supplied to the pen-drive unit; therefore, the slope of the waveform may be varied by means of this control.

(2) Under certain conditions the transition from one pen position to the other may become too rapid and it may be desired to artificially slow down this movement. This is accomplished by capacitors 214 and 215. Actually four values of capacitance are available and are switched into the circuit with the DISCRIMINATOR control (165). This part of the circuit is especially desirable in preventing spurious responses from certain types of interferences such as ignition noise, but it should be used at the lowest possible setting because it limits the top speed at which the recorder can operate.

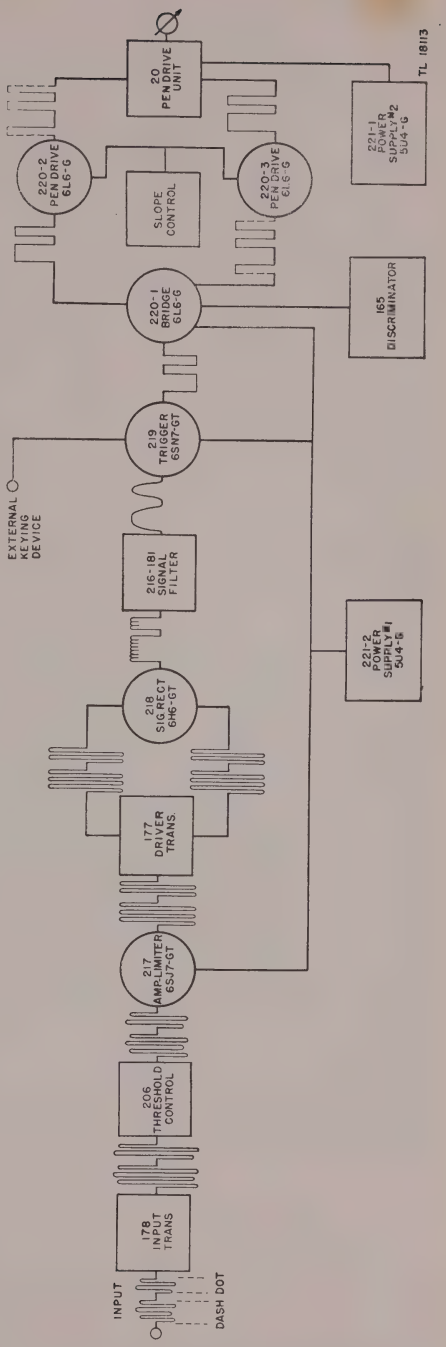


Figure 3. Functional block diagram.

SECTION II

DIFFERENCE BETWEEN MODELS

4. Operational Difference

Recorder BC–1016 is manufactured in only one model. There is no operational difference between any equipment.

5. Design Differences

a. Certain circuit changes were made in the equipment after manufacture of the first sets. MWO SIG 11–441–1 has been issued to make all equipment conform with equipment now being made. The following data give the order numbers and serial numbers of the obsolete type circuits. (Check the order and serial numbers of your set to determine whether it is the obsolete type; if it is, check circuit to determine whether it has been modified.)

Order No.	*Unit serial No.*
14087–Phila–43	1–1289, inclusive
14146–Phila–43	1–319, inclusive
15559–Phila–43	1–444, inclusive

Equipment having order numbers and serial numbers listed above originally was made with resistor 196 in trigger-tube (219) cathode circuit. Resistors 200–2 and 201–2 were not in circuit. Reference symbol for resistor 200–1 was 200. See schematic diagram in figure 42.

Caution: Tube voltage and resistance readings will not conform with values given on voltage and resistance charts unless equipment has been modified.

b. Substitute wire was used as shown below on Order No. 15559–Phila–43, Serial Nos. 1 to 200 inclusive.

Per Diagram	*Substitute*
Orange	Yellow-ends dipped in orange paint.
Orange	Yellow with black tracer.
Red-black tracer	Red with ends dipped in black paint.
White-red tracer	Red with ends dipped in white paint.
White-brown tracer	Brown with ends dipped in white paint.
White-black tracer	Black with ends dipped in white paint.
Blue-yellow tracer	Yellow with ends dipped in blue paint.

SECTION III

INITIAL REPAIR PROCEDURES*

6. General

Methods of locating trouble in electronic equipment are numerous and many untrained repairmen use various rule-of-thumb techniques that will detect some troubles but fail to locate others. Other technicians with a good understanding of radio theory, but who do not have practical experience, often will indulge in a roundabout method of trouble location when an obvious symptom would have isolated the defective part immediately. By following the procedure outlined in this manual, any source of trouble in the recorder can easily be located and repaired in the shortest time possible. In addition to locating a specific defect, the step-by-step procedure will enable the repairman to thoroughly overhaul the equipment, restoring it to an operating condition comparable to that of new equipment.

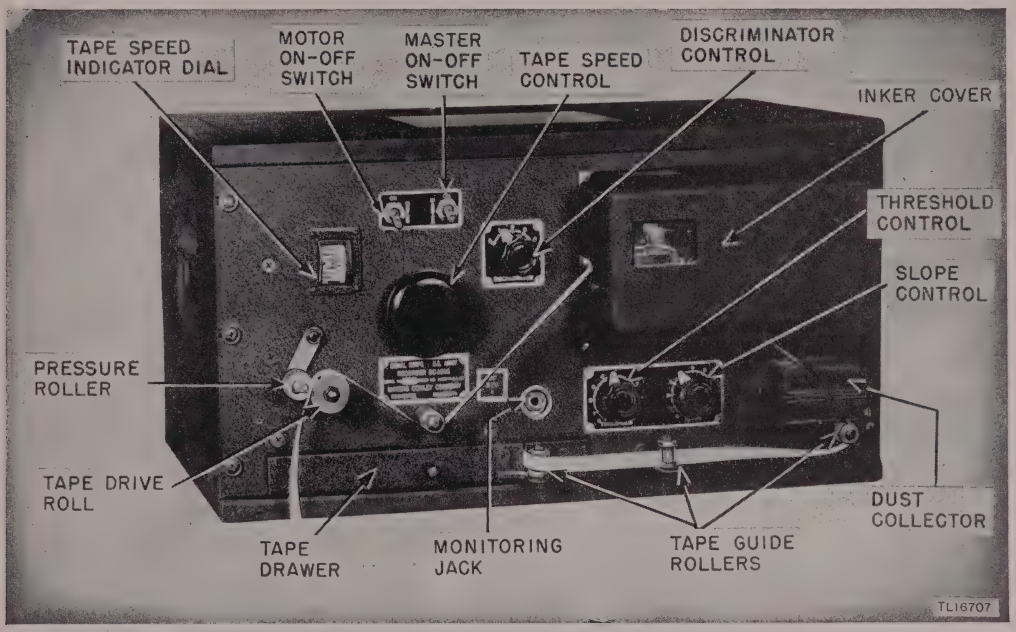


Figure 4. Recorder and front panel parts.

7. Special Test, Tool, and Cleaning Equipment for Recorder BC–1016.

The test, tool, and cleaning equipment listed below should be available for repairing and overhauling Recorder BC–1016.

* Before any repairs or adjustments are made, all authorized modification work orders should be applied. See FM 21–6 for list of applicable MWO's.

a. TEST EQUIPMENT.

Item	Description
Tube tester	Standard emission type.
Voltohmmeters	Sensitivity of 20,000 ohms per volt, capable of measuring a-c or d-c voltages from 0 to 500 volts and resistance from 1 ohm to 5 megohms.
Capacitor tester	Capable of testing capacitances from 0.01 to 5 mf.
Signal generator	Capable of providing an independent audio output from 0 to 10 volts at 500 and 1000 cps with an impedance from 50 to 200 ohms.
Receiver	Capable of receiving coded c-w signals, preferably with c-w oscillator (such as BC–312).
Resistors	50, 100, and 200 ohms = 1 watt.

b. TOOLS

Item	Description
Radio repair hand tools	Assortment.
Feeler gauge	0.001 to 0.01 inch.
Hone	Small, fine grade.
Allen head wrench	0.0625″ hex. head, type Nos. 5 and 6.
Allen head wrench	0.078″ hex. head, type No. 8.

c. CLEANING EQUIPMENT.

Item	Description
Solvent, Dry-cleaning	
Ammonia	
Small flashlight or probing light	
Sandpaper	#000 and #00.
Clean cloths	Lint-free.
Crocus cloth	
Paint brushes	Assorted small sizes.

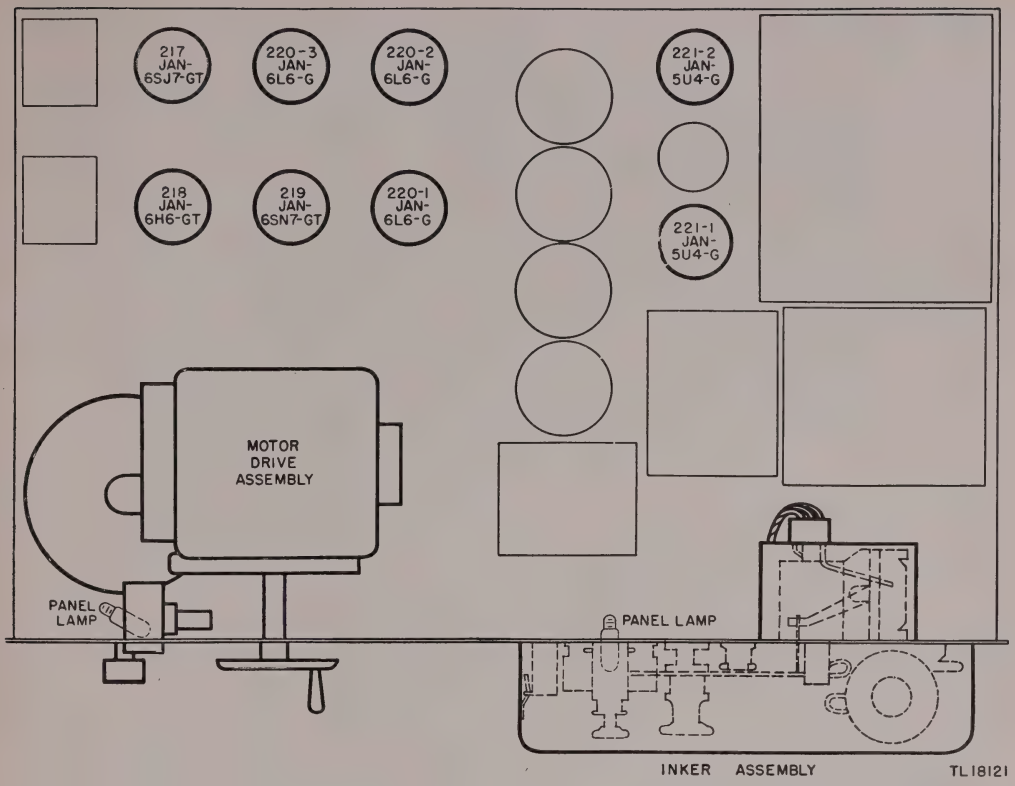


Figure 5. Location of recorder tubes, panel lamps, motor drive assembly, and inker assembly.

8. Removal of Tubes

The eight vacuum tubes are removed by opening the top cover of cabinet and pulling the tubes from their sockets. If a tube sticks in socket, rock it gently as you pull. The two panel lamps are mounted in holders which clip to the panel. Detach clips and remove lamps.

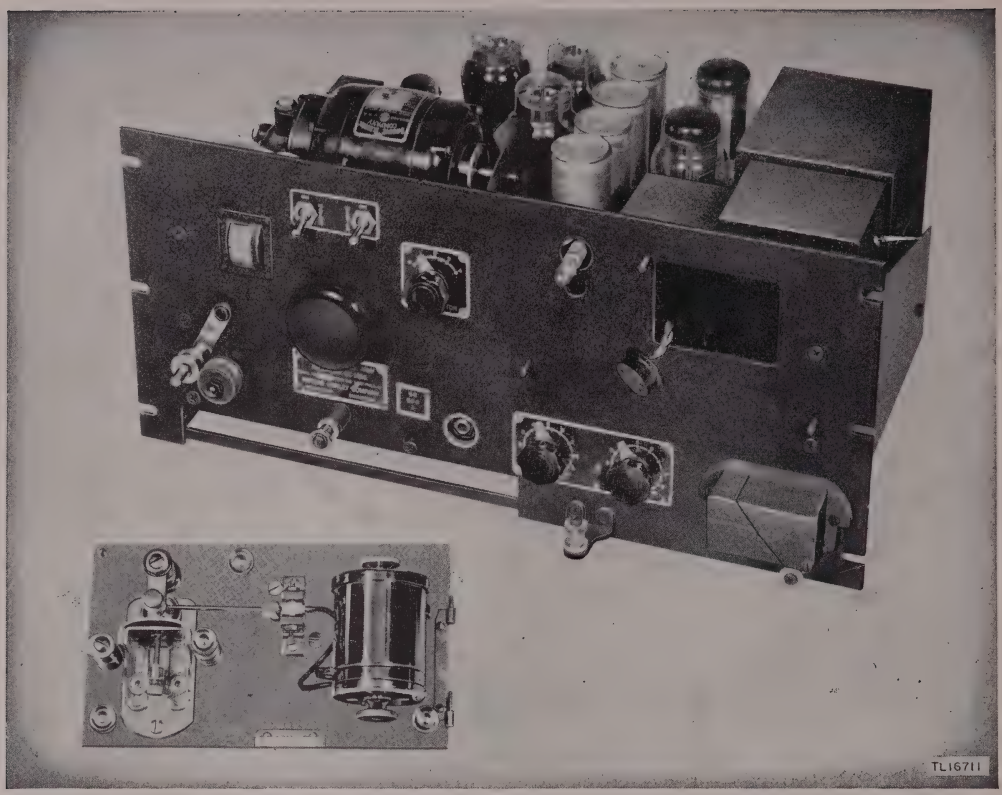


Figure 6. Inker assembly, cover, and tape drawer removed from recorder.

9. Removal of Inker Assembly

a. Open inker assembly cover (52) and lift cover from panel.

b. Tighten ink cup cover and see that pump is OFF to avoid spilling ink.

c Loosen three knurled fastening screws of inker assembly (See fig 8.)

d. Pull out separable attachment plug (189) and remove inker assembly from recorder panel.

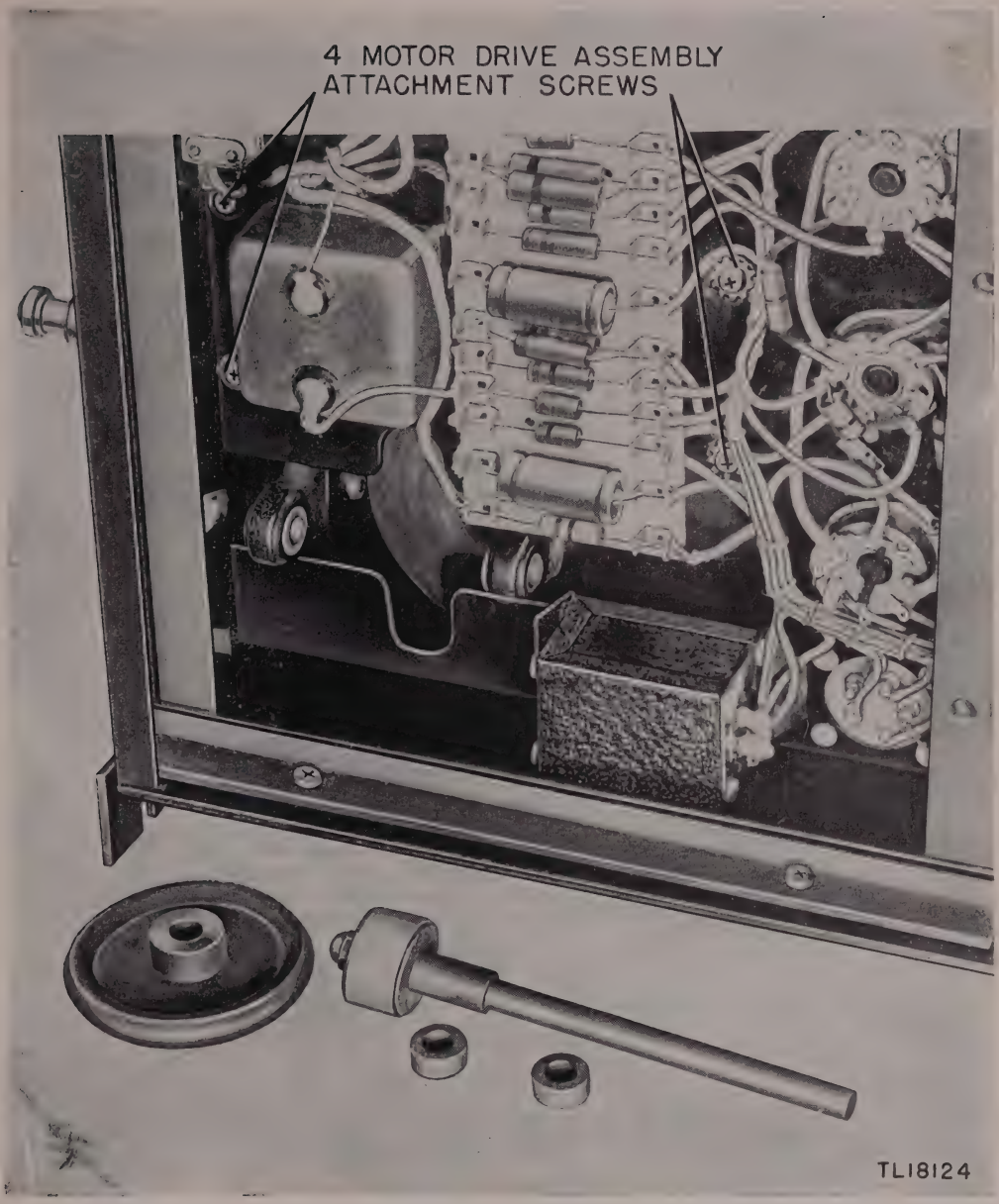


Figure 7. Motor drive assembly attachment screws.

10. Removal of Motor Drive Assembly

a. Initial Procedure. (1) Remove chassis from cabinet by removing the three recessed head screws at each end of the panel and the three screws and nuts on the bottom rear of chassis. Slide chassis from cabinet.

(2) Turn chassis upside down and remove four small recessed head screws holding bottom cover to chassis.

(3) Remove two screws at rear of tape drawer and slide drawer from chassis.

(4) Remove two screws on tape drawer cover frame and slide cover to the left until it can be taken out of chassis.

b. Motor Drive Assembly Removal Procedure. (1) With chassis bottom side up, use Allen wrench (0.078″ hex. head) to loosen setscrews in the two tape drive shaft collars (87) and setscrews in driven wheel hub (84) as shown in figure 35. Pull tape drive shaft from assembly as shown in figure 7.

(2) Loosen setscrew holding tape speed control knob (91) to shaft. Remove knob.

(3) Unscrew the four recessed head screws (fig. 7) holding motor drive assembly to chassis.

(4) With drive assembly in one hand, unscrew two screws that hold electrical terminals to motor. Complete drive assembly can now be removed from chassis.

11. Cleaning, Inspection, and Lubricating of Chassis

a. Preliminary Cleaning of Sets Exposed to Sand, Silt, or Salt Water. (1) If equipment has been submerged or subjected to salt spray, it is important to remove all traces of sand or salt from the set. Silt or beach sand in the equipment often will deposit small crystals of salt between tube prongs and socket pins and in small crevices that will short electrical circuits.

(2) If chassis contains sand or silt, or if the characteristic white salt crystal formation is visible in the equipment, flush the set thoroughly in clean, fresh water. Wipe insulation, tube sockets, switch contacts, etc., carefully with a clean rag soaked in fresh water. Place equipment in a drying oven at a temperature not exceeding 125°F. until it is thoroughly dry.

b. General Cleaning Procedure. Instructions in the latest Signal Corps publications on the general subject of cleaning should be followed. The procedure may be supplemented by the following steps.

(1) Use jet of clean air to blow out dirt from inside and top of chassis.

(2) Use screw driver or other sharp tool to scrape off drops of solder.

(3) Dampen a clean, lint-free cloth with dry-cleaning solvent (SD) and wipe equipment free of oil and grease. A pointed tool wrapped with a strip of cloth should be used to clean hard-to-reach points.

(4) All traces of rust or corrosion on metal parts should be scraped off and finished with #000 sandpaper.

(5) All traces of fungi should be removed by scraping and sanding. Materials containing cellulose, such as insulation, adhesive cement, wood, and certain plastics are especially susceptible to fungus growth.

(6) Open dust collector cover and clean accumulated dirt from brushes.

c. Inspection Procedure. Make a general visual inspection of chassis in accordance with customary shop practice. Time often can be saved in repair of equipment by inspecting for certain obvious defects before an elaborate diagnosing program is entered upon. Pay particular attention to the following items.

(1) Notice if there are any signs of wax, tar, or other insulating material that has melted and dripped from condensers, transformers, chokes, etc. Such a sign would indicate the part has been overheated and probably is defective.

(2) Inspect tape guide rollers (134 and 136) and pressure roller (106) to determine that each turns freely. If roller will not spin easily, remove screw holding roller to panel and clean bearing area with sandpaper.

(3) Inspect wire winding of SLOPE control (207). If signs of wear are evident, control should be replaced.

(4) Inspect for loose connections, frayed or burned insulation, loose screws, and burned or charred resistors. Examine tube sockets for broken contacts.

d. Bearing Lubrication. Care should be observed in lubricating parts of the recorder. In many cases as much harm can be done by *overlubrication* as underlubrication. Just enough Oil, Clock and Watch, should be applied to part to penetrate bearing. Always wipe off excess lubricant. Apply a few drops of Clock

and Watch oil (OCW) to bearings of tape guide rollers (134 and 136) and to pressure roller (106). Lubricate camshaft (103). No other parts of chassis requires lubrication.

12. Cleaning, Inspecting, and Testing of Tubes

a. CLEANING AND INSPECTING. Clean tubes with a cloth moistened with dry-cleaning solvent (SD) and, if necessary, clean prongs with crocus cloth. Examine tube to see that glass envelope is tight in base and that base is not cracked. If cement holding envelope in base has deteriorated, tube should be renewed.

b. TESTING. Tubes should be tested in any type of conventional tube tester and should meet JAN specifications.

Note. It is important that the two 6L6–G pen-amplifying tubes (220–2 and 220–3) should test approximately the same value. In replacing tubes in the set, remember to put the two 6L6–G's that tested the most nearly identical in the 220–2 and 220–3 sockets.

13. Cleaning, Inspecting, Testing, and Lubricating of Inker Assembly

The satisfactory operation of the recorder depends in great part on the proper functioning of the inker assembly. Improper adjustment, clogged ink channels, or defective parts in this unit will completely thwart the operation of the equipment although electrical components are in perfect working order. See figures 8 and 34 for location of parts.

a. CLEANING. (1) *Ink cup.* (*a*) Pull transflex ink tubing (57) from pivot block connection.

(*b*) Slide ink cup up in its bracket until it comes off.

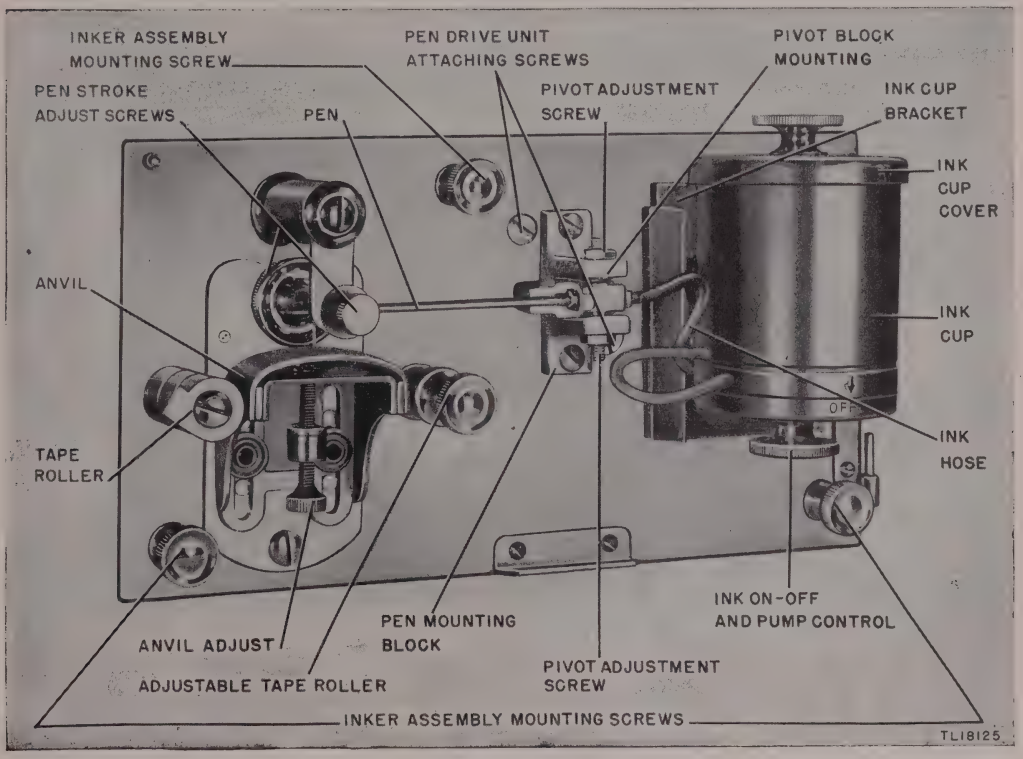


Figure 8. Inker assembly.

(*c*) Unscrew top of ink cup (12) and empty ink.

(*d*) Turn manual pump (7) to ON and fill cup with warm water to clean (if Higgins' ink

has been used it will be necessary to clean with ammonia).

(*e*) Turn pump clockwise (to right) until cleaning solution comes out of tube.

(*f*) Using an Allen wrench, release setscrew in knob of manual pump at bottom of cup. This will allow removal of knob and dial. Remove three screws, locating spring (6), and plate (4), exposing pump cam. (See fig. 9.)

(*g*) Examine transflex ink tube. If it is cracked or badly flattened and does not regain shape when not compressed, it should be replaced.

(*h*) Clean out old and caked grease with small paint brush and dry-cleaning solvent (SD). Before reassembling, apply a small amount of Grease, Lubricating, Special to moving parts of pump.

(*i*) Reassemble ink cup using new neoprene gasket (11) for ink cup cover if old one is defective or does not seal cup.

(2) *Pen.* (*a*) Lower tape anvil (29) about 1/4 inch below pen point and pull pen from connection on pivot block. (Depress clip to release pen.)

(*b*) Clean pen point by using pen reamer to remove ink particles which may have clogged point. (Reamers are in small glass container in tape drawer.) It is advisable to clean each pen at this time. Pens should be washed in warm water or ammonia.

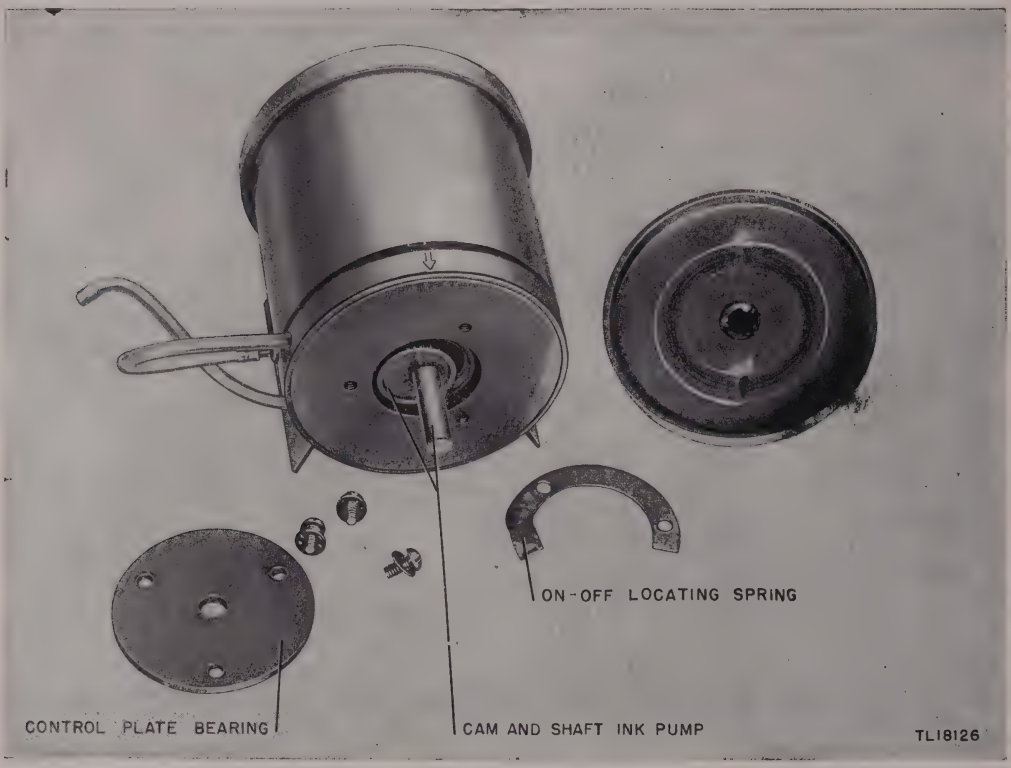


Figure 9. Disassembly of ink pump.

(3) *Inker Panel.* Clean oil and grease from pivot block and other parts with dry-cleaning solvent (SD). Remove ink stains with warm water or ammonia.

b. INSPECTING. (1) Inspect anvil adjustment screw (33) and pen stop screws (24 and 28) to see that they work freely and are not bent or defective. See figure 33 for location of all inker assembly parts.

(2) If plastic pen stops (56) are worn to

extent that less than $\frac{1}{16}$ inch is protruding from pen stop screws, renew, applying a small amount of collodion cement to the end of pen stop before insertion.

(3) Remove pivot screws and examine to see that bevel point is not worn. If screw is worn it must be replaced. Pivot screws should be adjusted so that pivot block swings freely but without up and down play. See paragraph 34*c*(2)(*b*).

(4) Take off pen drive unit cover (55) by removing two acorn nuts (19). Inspect copper link from pivot block to armature of pen drive unit to determine that it is not bent and that solder connection is not broken. Link should be at approximately right angles to pivot block.

(5) Check armature for free movement between electromagnetic coil (20). This part often becomes rusted and sticks to coil. If armature cannot be easily freed, complete drive unit should be replaced. See paragraph 34*c*(1) for procedure.

(6) Check plain tape roller (42) and adjustable tape roller (44) for sticking. If rollers do not turn easily, remove and clean bearing shafts.

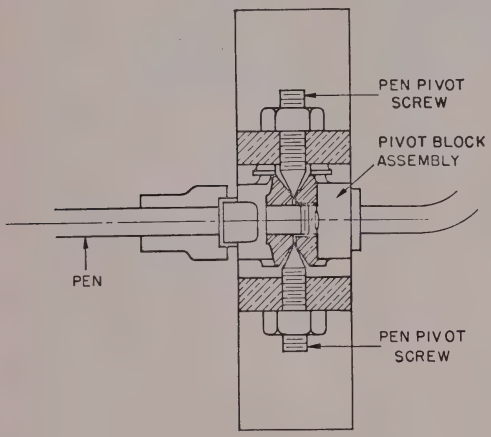


Figure 10. Pivot block and adjustment screws.

c. TESTING. (1) *Electromagnetic coil (20).* Use ohmmeter to test resistance between prongs Nos 1 and 2, and prongs Nos. 1 and 3. (See fig. 34.) Each reading should be approximately 125 ohms. A reading 10 or 15 percent less would indicate a short in the coil; no reading would indicate an open circuit. The entire pen drive unit should be renewed if either of these conditions is found See paragraph 34*c*(1) for procedure.

(2) *Ink cup leakage.* (*a*) Rotate pump knob (7) to OFF.

(*b*) Disconnect ink tube from ink cup and submerge outlet tube in water. Blow into inlet tube as shown in figure 11.

(*c*) Result: No bubbles should appear. If bubbles appear, ink tube is leaking at shut-off point.

(*d*) Remedy: Replace tube.

Figure 11. Ink cup leakage test.

(3) *Pivot block leakage.* (*a*) Fill ink cup with ink or water. With ink tube connected to pivot block, rotate pump knob clockwise until fluid comes out of pivot block outlet.

(*b*) After fluid appears, hold finger over outlet as shown in figure 12.

(*c*) Continue to rotate pump to the right.

(*d*) Result: Pivot block should not leak.

(*e*) Remedy: If pivot block leaks it must be replaced. (See par. 34*c*(2).)

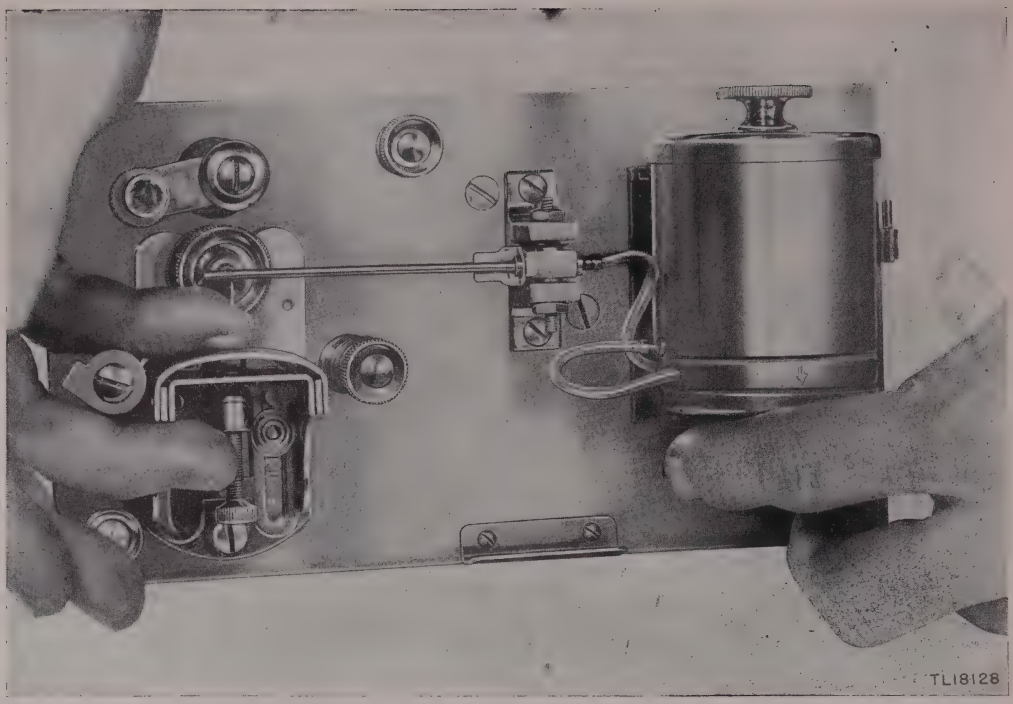


Figure 12. Pivot block leakage test.

(4) *Tape anvil (29) adjustment.* (*a*) With pen in place, raise tape anvil to within 0.005 inch of pen.

(*b*) Adjust front and rear pen stops for 3/8-inch pen travel.

(*c*) Move pen from front to rear stop by pushing on ink tube connection of pivot block.

(*d*) Result: Gap between pen point and anvil must be uniform between stops. (Measure clearance with feeler gauge.)

(*e*) Remedy. With long-nosed pliers carefully bend anvil until it is same distance from pen point for all positions of pen.

d. LUBRICATION. Place drop of clock and watch oil (OCW) on each pivot point and on the bearings of the two tape roller shafts.

14. Cleaning, Inspecting, Testing, and Lubricating of Motor Drive Assembly

a. CLEANING. If motor does not show signs of long, hard usage and is not caked with dirt or grease, it can be cleaned without disassembly. If it is necessary to clear motor by brushing inside housing with dry-cleaning solvent (SD), motor must be disassembled. To disassemble motor see paragraph 35*c*.

(1) Clean all parts of motor drive assembly thoroughly with dry-cleaning solvent (SD). Remove any rust or corrosion on motor guide rods (71) or other parts. Clean out threads of tape speed control screw (74). Clean cellulose indicator dial with ammonia.

(2) If motor does not require disassembly, remove plug on top of motor at gear box and blow jet of air through motor housing.

(3) If motor is disassembled, use dry-cleaning solvent (SD) to carefully clean inside of motor housing. If grease is old and caked in gear housing and around bearings, clean it out and renew lubricant. (See *d*(4) below.)

b. INSPECTING. (1) Turn tape speed control screw to see that motor moves freely. Inspect speed control screw for defective threads. There should not be more than one-quarter turn of play in speed control screw before motor moves. If there is more than one-quarter turn of play, loosen setscrews in one end plate and take up play in screw. If this adjustment does

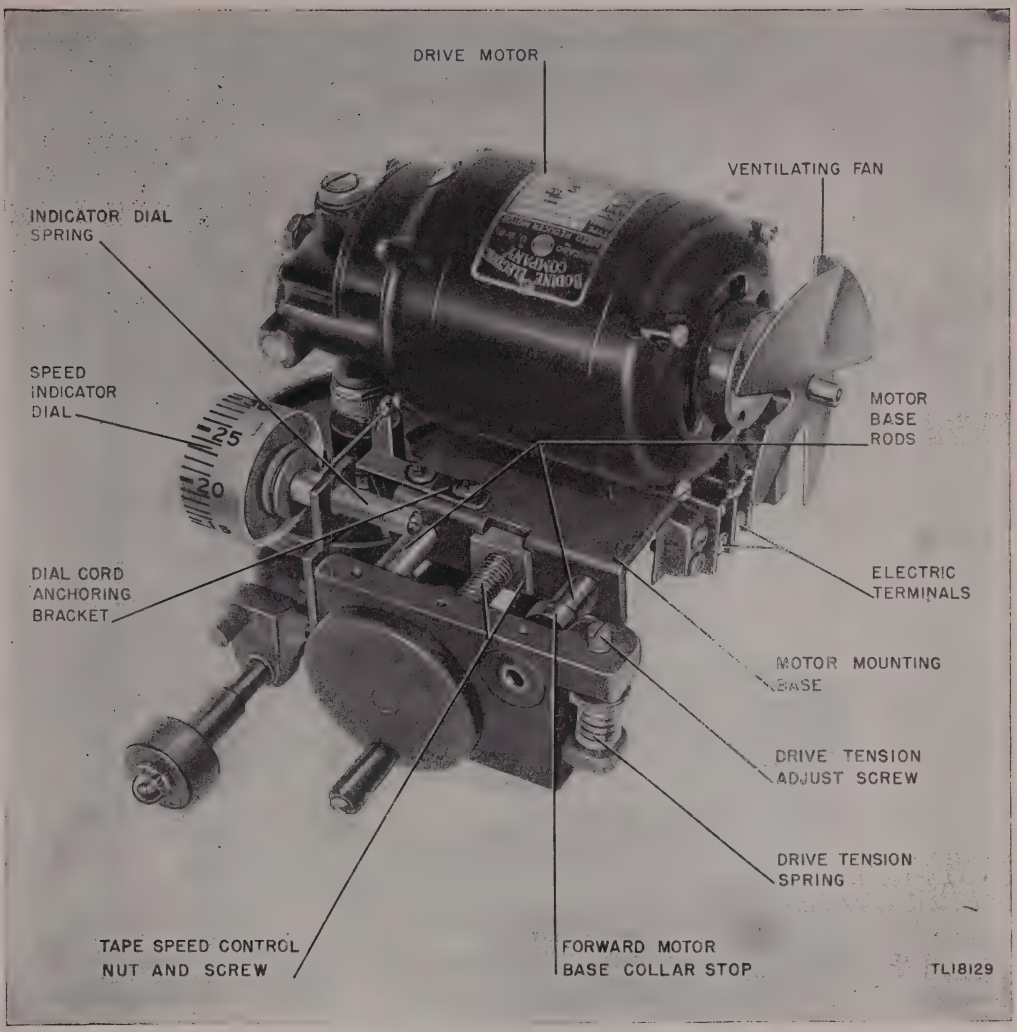


Figure 13. Motor drive assembly, front.

not take up play, renew screw (73) and nut (74). See figure 35 for parts location.

(2) Inspect neoprene driven ring (97). If worn, replace. Rubber ring can be slipped on driven disc (85).

(3) Inspect speed indicator cord (92). If frayed or broken, replace.

(4) Inspect speed indicator dial for proper operation.

(5) Note that indicator dial reads 5 and 35, respectively, for two extreme positions of motor. Adjust motor front stop collar (87) and indicator cord to obtain proper reading.

Note. For repair of motor drive assembly, see paragraph 35.

c. TESTING. There is only one conclusive test of motor drive assembly and that is to apply power to motor and operate it. This can easily be done by connecting a 110 a-c, 50–60 cycle source of power to motor terminals. If motor and drive discs operate properly, the unit is satisfactory. (Friction drive disc (72)

should turn at approximately 97 revolutions per minute (rpm)). If motor does not operate, see paragraph 35 for replacement procedure.

Note. Final adjustments of motor drive assembly are made in paragraphs 24, and 25 after assembly is remounted on chassis.

d. LUBRICATING. (1) Apply a small amount of Grease, General Purpose No. 2 to the speed control screw (73) and to the associated motor base rods (71). Lubricate the speed control screw bearings with clock and watch oil (OCW) through the oil ducts in each end plate.

(2) The tape drive shaft (86) is equipped with two porous bronze bearings (69) which should be lubricated with a few drops of light mineral oil.

(3) Apply a few drops of clock and watch oil (OCW) to the speed indicator shaft and bracket pivots (68).

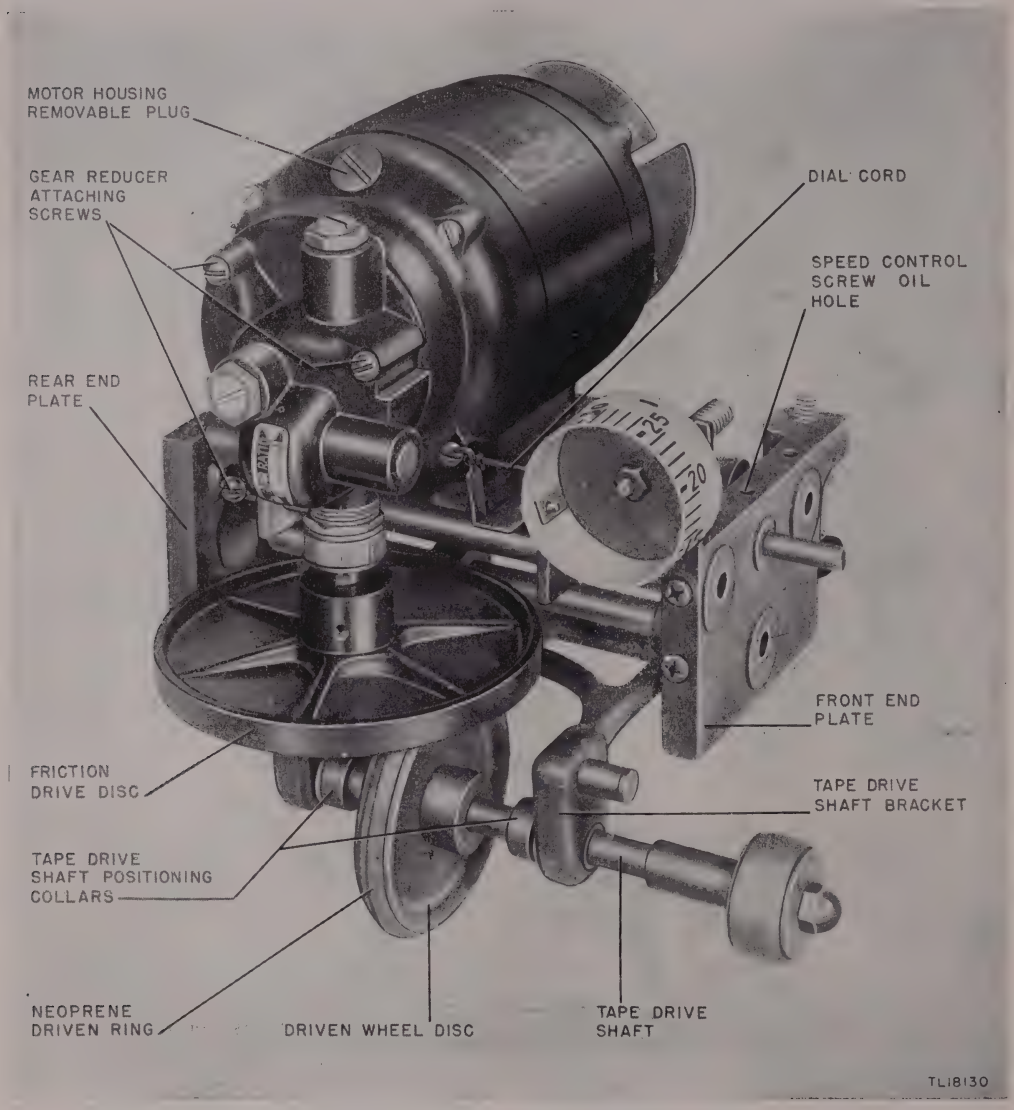


Figure 14. Motor drive assembly, side.

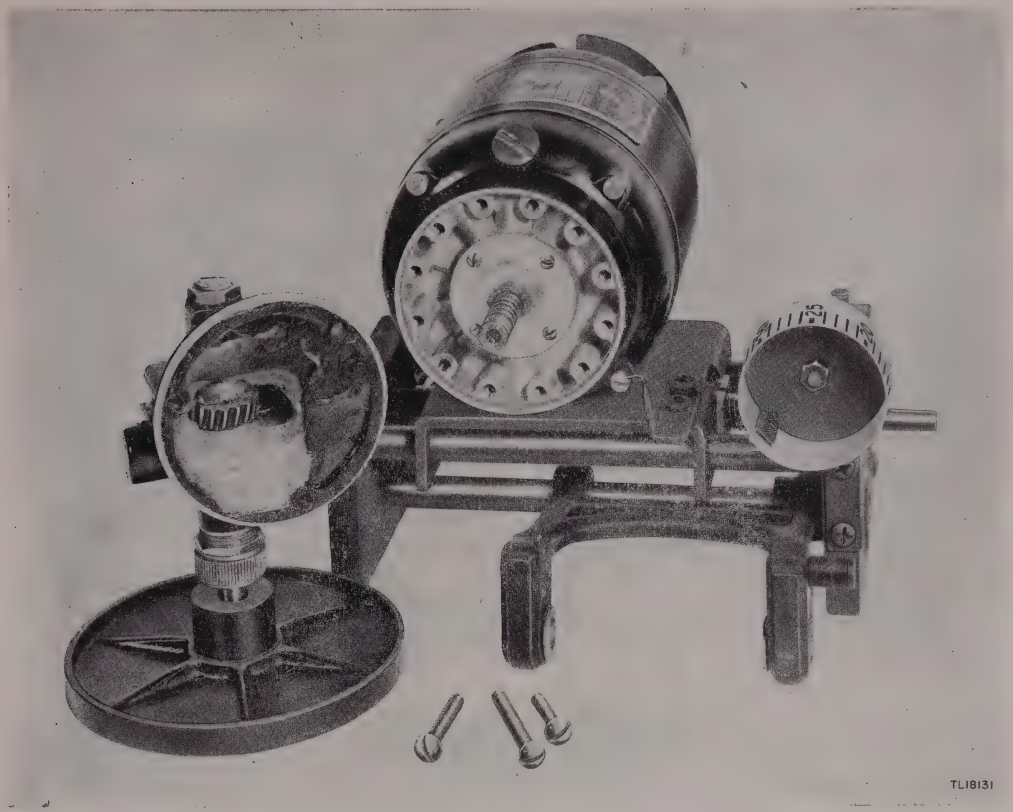


Figure 15. Motor drive assembly with gear housing removed.

(4) If motor operates satisfactorily and it is not necessary to dissemble it for repairs, no lubrication is required. If motor has been disassembled and grease cleaned from gear box and armature shaft bearings, they should be repacked with general purpose grease (WB). If recorder is to be operated where temperatures are lower than 0°F., the grease in gear housing and bearings should be replaced with Lubricant, Gear, Universal.

SECTION IV

PRELIMINARY TROUBLE-SHOOTING PROCEDURES

15. Input Resistance Measurements

By measuring the input resistance of transformers 176 and 175, a short or open circuit in wires carrying the 110-volt a-c power can be detected without applying power to the equipment. By determining the condition of these circuits before turning on the power, damage that might otherwise result can be avoided. Make measurements with motor disconnected from power leads.

a. TRANSFORMER (176). (1) With MASTER switch ON, MOTOR switch OFF, and line switch (188) on setting marked "117", test for resistance at input terminals (185).

(2) Result: Approximately 3.25 ohms. If reading is incorrect by more than 1 or 2 ohms, a short in transformer (176) is indicated. If no reading is obtained, either fuse (168), switch (164–1), wiring, or transformer primary is open.

(3) Remedy: Check switch, fuse and wiring. If not defective, transformer is at fault and should be replaced. In replacing transformer, unsolder wires, tagging each with corresponding number on transformer lug.

b. TRANSFORMER (175). (1) With MASTER and MOTOR switches OFF, disconnect the two motor leads and measure the resistance between them.

(2) Result: Approximately 13 ohms. If reading is incorrect, check wiring to input lugs of transformer (175).

(3) Remedy: Replace transformer.

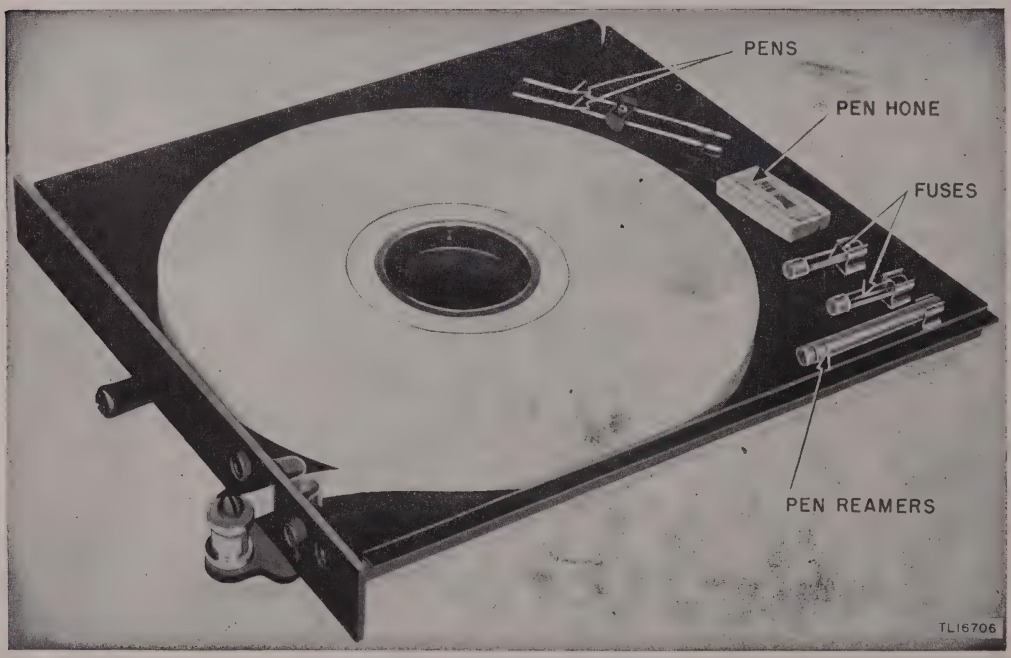


Figure 16. Location of tape in drawer.

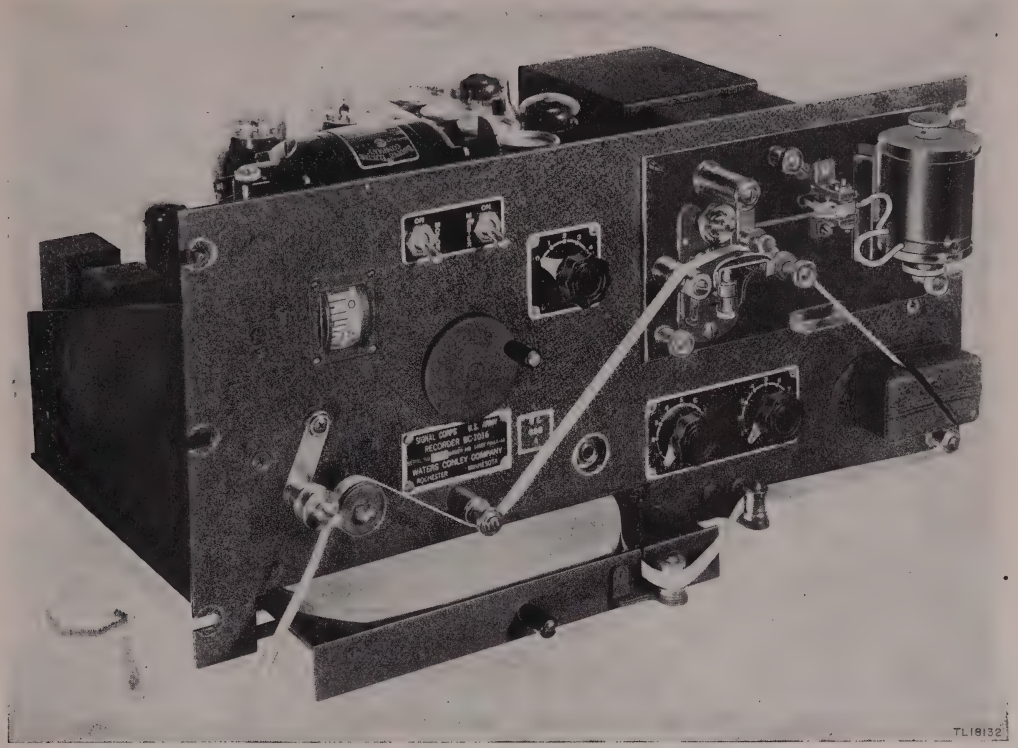


Figure 17. Recorder with tape in position for operation.

16. Operating Test

The preceding tests, inspection, and repairs show that the movable parts are in working order and that the equipment should operate unless there is trouble in the electrical circuits of the recorder. The tubes, panel lamps, inker assembly, and motor drive assembly should be replaced and the set prepared for operation.

Note. End play in tape drive shaft (86) of motor drive assembly should be approximately 0.002 inch. Adjust two collars (87) for proper clearance.

a. PRELIMINARY PROCEDURE. (1) Place roll of tape in drawer as shown in figure 16 and thread it through tape guide rollers, dust collector, and tape drive roll as shown in figure 17. Adjust tape guide roller (44) so that tape is centered on anvil.

(2) Adjust pen stopscrews for pen swing of about $\frac{3}{16}$ inch. Fill ink cup about $\frac{2}{3}$ full. Adjust anvil so pen just touches tape.

(3) Check value of fuse. For operation on 117–170 volts, a 3-ampere fuse is used; for 210–240 volts, a 1½-ampere fuse is used. Check a-c input stitch (188) for correct operational voltage.

(4) Connect a signal source. The most reliable test of recorder operation is obtained by recording an actual continuous-wave (c-w) signal. Use a receiver such as Radio Receiver BC–312–( ) or BC–342–( ) and select a code transmitting at least 250 words per minute. Output of receiver should be at least 5 volts for recorder operating test. See TM 11–441 if additional operating information is required.

(*a*) Normally connect two outside input terminals of recorder across the voice coil of receiver loudspeaker, figure 18Ⓐ.

(*b*) If additional sensitivity is required because the receiver voice coil impedance is low or receiver output is low connect as shown in figure 18Ⓑ.

(*c*) If still greater sensitivity is desired, an impedance matching transformer may be connected in the circuit, figure 18Ⓒ. Transformer ratio should be about 10 to 1; the low impedance side is bridged across the speaker voice coil.

(*d*) See TM 11–441 for other input connections.

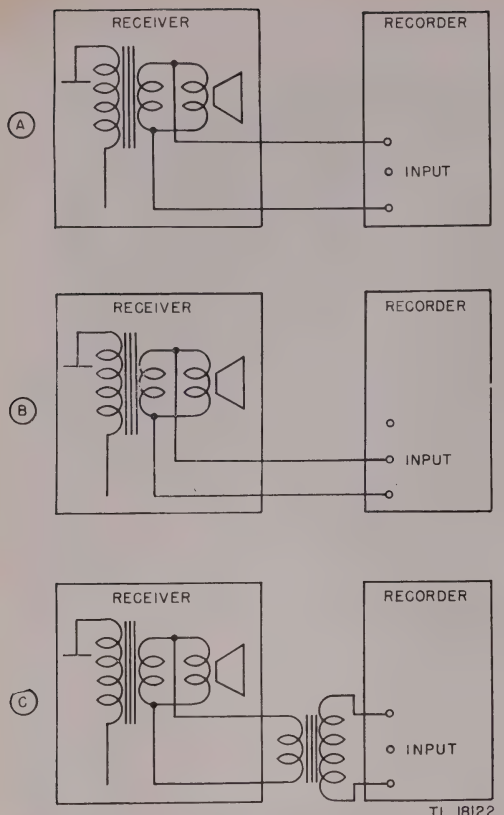


Figure 18. Input connections.

Caution: No direct current should be applied to input of recorder. If direct current is present insert a blocking capacitor from 0.10 to 0.25 mf.

b. TESTING RECORDER BC–1016. (1) Turn MASTER and MOTOR switches ON. While set is warming up, it is advisable to notice any abnormalities in operation. Listen for crackling or buzzing noises which indicate arcing of the high voltage. Check the recorder for smoke, and the odor of burned or overheated parts.

(2) Turn on companion receiver or signal source.

(3) Turn manual pump clockwise until ink comes from pen point. Leave pump ON while recorder is in operation.

(4) With tape running, advance the THRESHOLD control until pen is moved by the signal. Advance control just beyond the threshold point. Adjust SLOPE control until pen gives an even recording. Keep SLOPE control as close to 0 as possible. DISCRIMINATOR control should be kept at 0 unless discrimination against noise is required for clean recording. Increasing DISCRIMINATOR lowers the top speed at which recorder can function.

(5) If recorder operates but indicates need for adjustment, see section VII. If recorder does not operate or functions badly, see section VI.

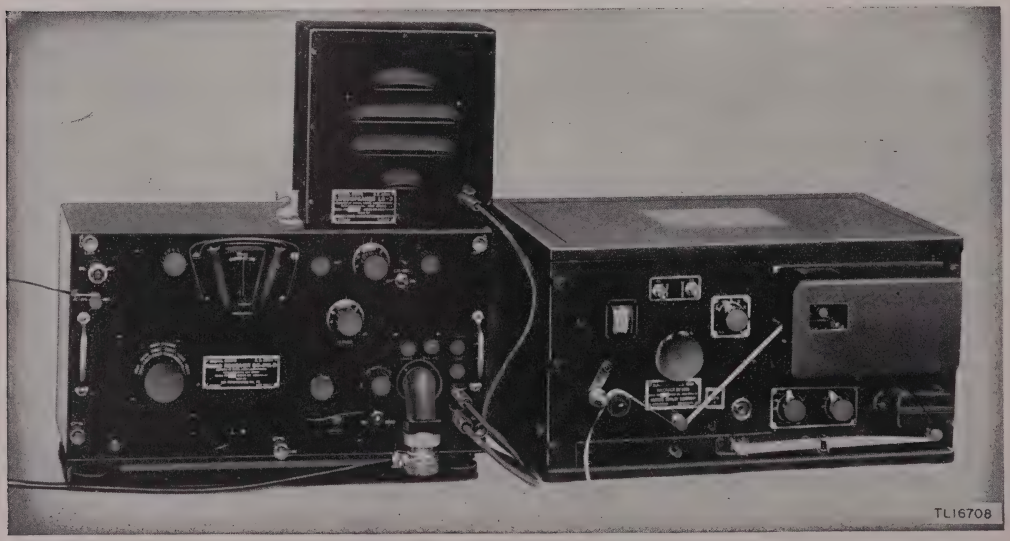


Figure 19. Recorder BC–1016 and companion receiver.

SECTION V

ALIGNMENT PROCEDURE

17. Alignment

Electrical circuit of Recorder BC–1016 does not require alignment. Improper passage of the signal from one stage to another can only be caused by defective wiring or parts. There are no trimmers or other adjustments for the electrical circuit except the operating controls on the front panel of the recorder. If recorder will not operate properly, see section VI.

SECTION VI

DETAILED TROUBLE-SHOOTING PROCEDURES

18. Signal Tracing

The audio signal that enters the recorder cannot be traced through the circuit in the conventional signal tracing manner because it is rectified by Tube JAN 6H6GT(218) and the signal is in the form of direct-current pulses through the set. Although the signal itself cannot be conveniently traced, it is possible to determine whether the signal is going through each stage properly by measuring certain tube pin voltages both with and without an input signal. The "no signal" and "signal" voltages measured on each tube will indicate whether that stage is functioning. If a stage is found to be defective, see the paragraph covering the stage under the test in section VIII.

a. Preliminary Procedure. (1) Make set ready for operation as described in paragraph 16.

(2) Connect audio signal generator to the top and bottom input terminals of recorder. A 1-watt resistor should be shunted between input terminals of recorder to act as a load for the signal generator. It should be of a value close to the output impedance of the signal generator. (If impedance of signal generator is 100 ohms, the load resistor should be 100 ohms.)

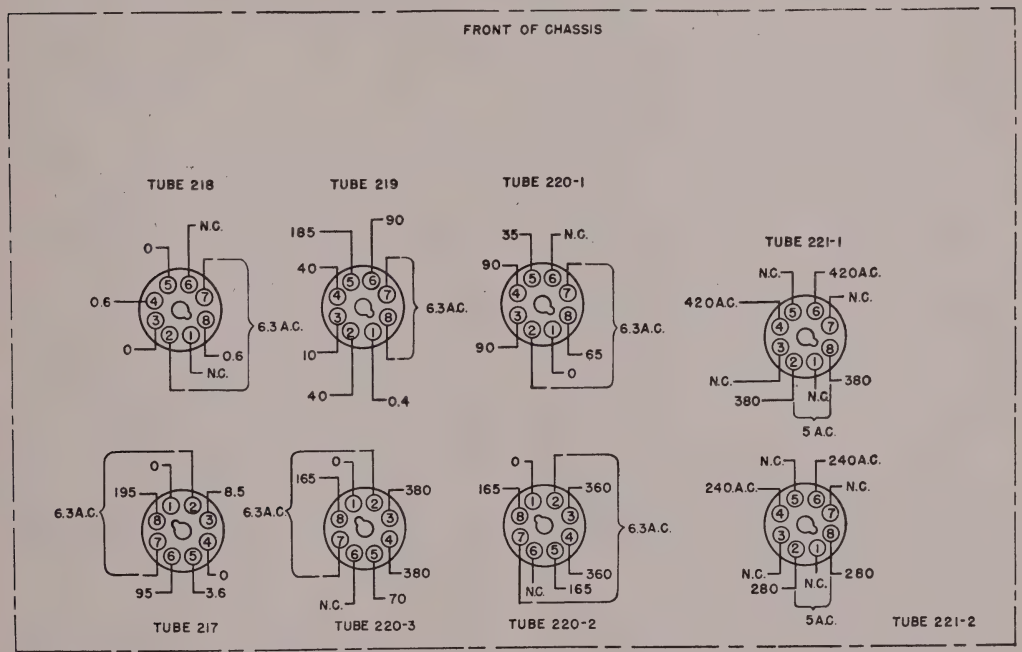
(3) For "signal" voltage readings, adjust signal generator for output of approximately 10 volts and frequency of 1000 cycles per second. For "no signal" voltage readings adjust output to 0 voltage or disconnect signal generator from input terminals.

(4) Make readings between indicated tube socket pins with a 20,000 ohms per volt instrument.

(5) SLOPE and THRESHOLD controls on No. 10. DISCRIMINATOR on 0.

b. Signal and No Signal Voltage Values Chart. The chart of average tube voltages gives correct voltage values between indicated pins with and without input signal. A variation of as much as 15 percent in voltage readings can be considered normal.

Tube reference No.	Grid to cathode		Cathode to ground		Plate to cathode		Input	
	Pins	Volts	Pins	Volts	Pins	Volts	No signal	Signal 1,000 cps 10 volts
217 6SJ7–GT			5-gnd	3.6	5–8	188	X	
			5-gnd	3.2	5–8	210		X
218 6H6–GT			8-gnd	0.0	—	—	X	
			8-gnd	2.0	—	—		X
219 6SN7–GT	1–3	8.1	—	—	2–3	84	X	
	1–3	0.0	—	—	2–3	0		X
	4–6	0.4	—	—	5–6	91	X	
	4–6	12.0	—	—	5–6	236		X
220–1 6L6–G	5–8	0.3	—	—	3–8	22	X	
	5–8	29.5	—	—	3–8	195		X
220–2 6L6–G	5–8	5.6	—	—	3–8	191	X	
	5–8	85.0	—	—	3–8	210		X
220–3 6L6–G	5–8	87.0	—	—	3–8	206	X	
	5–8	6.2	—	—	3–8	198		X

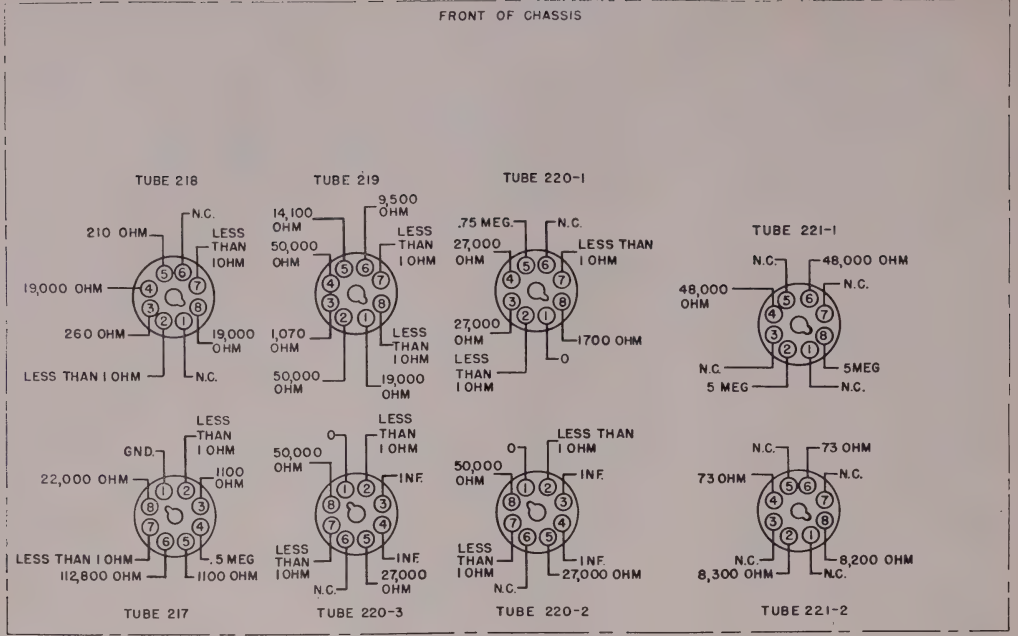


NOTE: READINGS MADE UNDER FOLLOWING CONDITIONS.

1. TUBES AND INKER ASSEMBLY PLUGGED IN.
2. NO SIGNAL.
3. THRESHOLD AND SLOPE CONTROLS ON 10.
4. 20,000 OHM PER VOLT INSTRUMENT.
5. FILAMENT READINGS BETWEEN PINS AS SHOWN.

TL 18102

Figure 20. Average voltage measurements at tube sockets, Recorder BC–1016.



NOTE: READINGS MADE UNDER FOLLOWING CONDITIONS.
1. TUBES AND PANEL LIGHTS REMOVED FROM SET.
2. INKER ASSEMBLY PLUG DISCONNECTED.
3. THRESHOLD AND SLOPE CONTROLS ON POSITION 10.

TL 18101

Figure 21. Average resistance measurements at tube sockets, Recorder BC–1016.

19. Voltage and Resistance Measurements

If set is inoperative and the trouble cannot be readily isolated to a certain stage, a test of tube socket voltages or resistance is the best method of trouble location. Preferred method of testing voltages is to start at amplifier-limiter stage and work toward power supply stages, disconnecting leads and isolating each stage until voltage readings are approximately normal. When defective stage is located, see pertinent paragraph of section VIII, and isolate and replace defective part See figures 20 and 21 for voltage and resistance values.

20. Moistureproofing, Fungiproofing, and Refinishing

After the receiver has been repaired, see TB SIG 13 for general instructions on moistureproofing and fungiproofing. If the receiver cabinet or chassis has been scarred or chipped, remove rough spots with #00 or #000 sandpaper and apply paint to spots with a small brush. If the cabinet is sufficiently scarred and scratched to warrant complete refinishing, it should be thoroughly cleaned of rust and dirt, and sprayed with paint authorized by existing regulations.

SECTION VII

FINAL TESTING

21. General

After repairs have been made and the equipment moistureproofed and fungiproofed, Recorder BC–1016 is in operating condition. Any fundamental malfunctioning should have been located and repaired in accordance with instructions in section VI. However, the following final tests must be conducted to correctly adjust recorder for optimum performance.

22. Sensitivity

a. Turn MASTER and MOTOR switches ON.

b. Turn THRESHOLD (206) to 10, turn SLOPE (207) and DISCRIMINATOR (165) to 0.

c. Set pen at front stop.

d. Attach signal generator to input terminals as described in paragraph 16*a*(4). Adjust signal generator for frequency of 1000 cycles per second and output of 0.6 volts.

e. Result: Upon application of signal, pen should move from front to rear stop.

f. Remedy: If pen does not move, check pivot points, pen armature, and friction spring (figs. 10 and 24) for free movement of pen.

23. Frequency Response Test

a. Turn MASTER and MOTOR switches ON.

b. Turn THRESHOLD (206) to 5, turn SLOPE (207) and DISCRIMINATOR (165) to 0.

c. Adjust signal generator for frequency of 1000 cycles per second and an output of just enough voltage to make pen move from front to rear stop.

d. Do not change output adjustment of signal generator but change frequency to 500 cycles per second.

e. Rotate THRESHOLD control from 0 to 10, and back again.

f. Result: Pen should move back and forth between stops.

g. Remedy: If pen does not move easily back and forth, tubes 220–2 and 220–3 are not in good condition or pen-actuating unit is out of adjustment. (See par. 34*c*.)

24. Speed Indicator Dial Calibration

This test is for the purpose of determining if speed indicator dial reads the speed with which the tape is actually passing through the recorder.

a. Set speed indicator (81) to 35.

b. Mark length of tape into 10-foot section.

c. Choose convenient reference point such as anvil or tape drive roll to determine time for passage of 10 feet of tape.

d. Turn MASTER and MOTOR switches ON.

e. Result: Time for 10-foot length of tape to run through recorder should be 17½ seconds ±1.

f. Set speed indicator to 5.

g. Result: Time for 10-foot length to pass reference point should be 120 seconds ±6.

h. Remedy: If both readings are incorrect by the same amount the dial can be adjusted by shortening or lengthening the cord that connects dial to motor mounting base. If one reading is correct and the other in error, it is necessary to reposition driven disc (85) on shaft. Loosen setscrew in hub of driven disc to change position of part. Position disc so that readings are correct.

25. Drive Tension Adjustment

This test is to determine the pressure of the driven disc against the drive disc.

a. Turn MASTER and MOTOR switches ON.

b. Adjust tape speed indicator to 25.

c. Suspend weight of 30 ounces on shaft of tape drive roller (96) as shown in figure 22.

d. Result: Tape roller should operate at constant speed.

e. Suspend weight of 44 ounces on shaft of tape drive roller.

f. Result: Roller should rotate intermittently or stop.

g. Remedy: Adjust drive tension screw (100). If this adjustment is still unsatisfactory, loosen setscrew in hub of friction drive disc (72) and reposition disc on shaft.

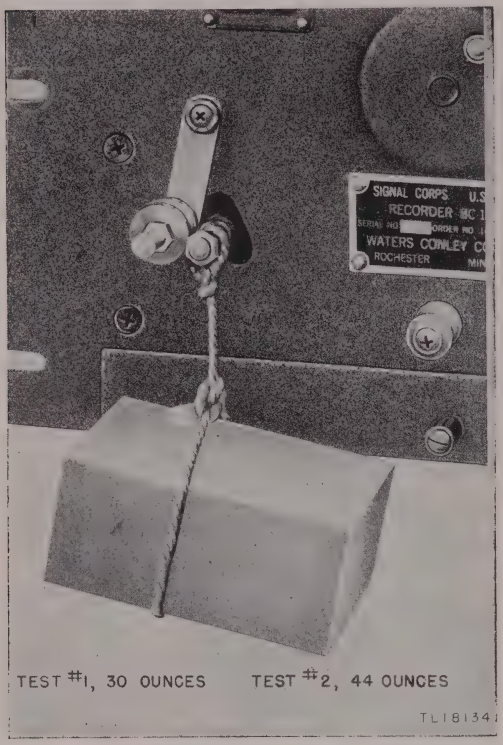


Figure 22. Drive tension adjustment test.

26. Operational Test

The operational test gives the final check on the operation of the recorder. When the various parts of the recorder performed satisfactorily under final testing, it was a good indication that everything was in order. However, it is the operational test, when all components work together, that gives the final proof as to the thoroughness with which the equipment has been overhauled. A conclusive test of the recorder operation requires a signal source producing at least 350 words per minute of c-w code. This is most conveniently obtained from a receiver capable of receiving a frequency carrying high-speed commercial code. If a suitable receiver is not available, a hand or automatic keyer can be connected directly to the KEY terminals on the rear of the chassis. With a keyer connected to the KEY terminals, the amplifier-limiter and signal-rectifier stages are nonoperative.

a. Slow-speed, Wide-line Pen Recording. (1) Insert wide-line pen and adjust pen swing for maximum of almost $\frac{3}{8}$ inch.

(2) Select a slow speed signal (less than 100 words per minute) and turn ON MASTER and MOTOR switches.

(3) Adjust tape speed for about 25 feet per minute.

(4) Adjust SLOPE control so that pen has enough power to make complete swing between stops.

(5) Recording on tape should be similar to figure 24.

(6) If characters on tape are irregular, broken, or otherwise unsatisfactory, a recheck of mechanical adjustments is necessary.

(*a*) Loosen locknut on pivot friction spring adjustment screw as shown in figure 23 and adjust spring tension until the pen makes clean characters.

(*b*) If pen pulls more to one side than to the

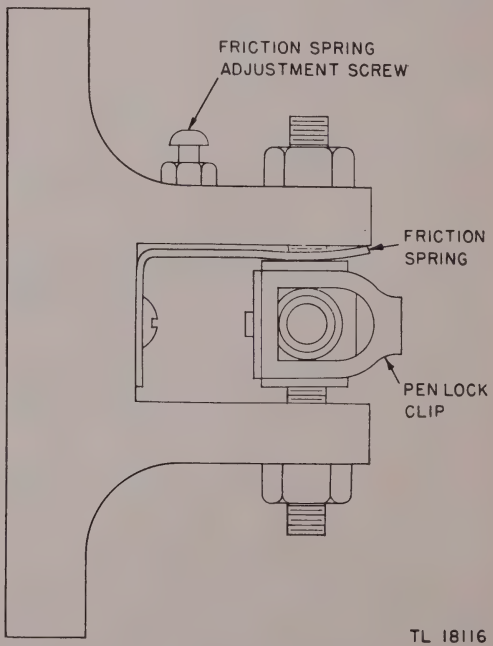


Figure 23. Friction spring.

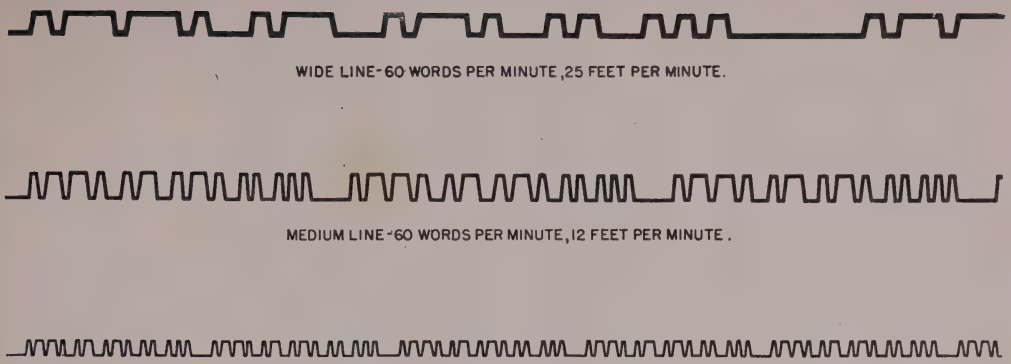


Figure 24. Wide- and fine-line pen recording.

other, remove pen drive unit cover, and reset the pen drive adjustment screw as shown in figure 34.

(*c*) If ink does not flow evenly, pen may require honing. (See *c* below.)

b. HIGH-SPEED, FINE-LINE PEN RECORDING. (1) Insert fine-line pen and adjust pen swing for about ⅛ inch.

(2) Select a high speed signal (more than 300 words per minute) and operate recorder. (It may be necessary to reduce pivot friction spring tension for high speed recording.)

(3) Adjust tape speed for about 30 feet per minute.

(4) Recording on tape should be similar to figure 24.

(5) If pen chatters or characters are unsatisfactory, recheck mechanical adjustments. If ink does not flow evenly, pen may require honing. (See *c* below.)

c. PEN HONING. If pen fails to ink tape properly even though ink flow is fully established, pen point may require honing to shape its lower end to the form shown in figure 24.

(1) Lower tape anvil so that a small hone may be slipped between pen point and anvil.

(2) Place hone in position parallel to anvil writing surface. Move pen back and forth several times, at the same time tilting the end of hone slightly upward, to grind the pen to form shown in figure 25.

(3) Remove pen from pivot block and set pen point on hone. Tilt and rotate at the same time to slightly round the edges. This removes any slight burr that may be present on the edges of the pen point. Replace pen in pivot block.

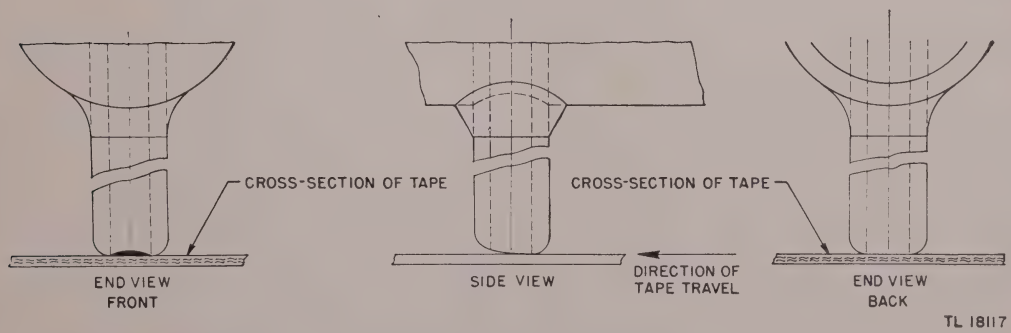


Figure 25. Pen honing.

SECTION VIII

INDIVIDUAL STAGE AND CIRCUIT REPAIR DATA

27. Power Supply No. 1 (fig. 26)

a. CIRCUIT REPAIR FEATURES. Power Supply No. 1 is composed essentially of a power transformer, high-voltage rectifying tube, and filter choke and capacitors. In addition to high-voltage output, the transformer has two 5.0-volt filament windings and one 6.3-volt filament winding. If tube socket voltage or resistance values are incorrect, parts should be tested individually. See parts list, *c* below for correct values. To test capacitors 211–3 and 211–4, each must be disconnected to isolate it from the circuit.

b. VOLTAGE AND RESISTANCE MEASUREMENTS. The voltage and resistance measurements shown in figure 26 are made at the pin connections to the tube socket on the underside of chassis. Connect the meter between the pin and chassis to obtain the reading unless otherwise indicated. Make test under the following conditions:

(1) *Voltage measurements.* (*a*) Use 20,000 ohms per volt voltmeter.

(*b*) No signal.

(*c*) THRESHOLD and SLOPE controls on 10, DISCRIMINATOR on 0.

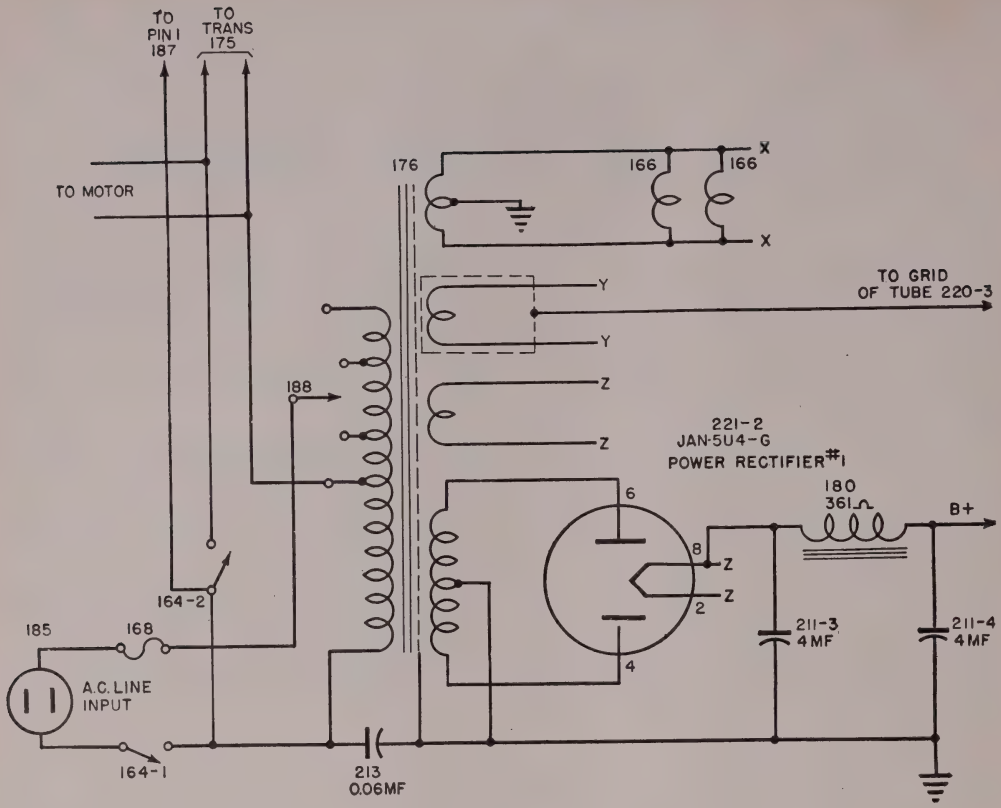
(*d*) MASTER and MOTOR switches ON.

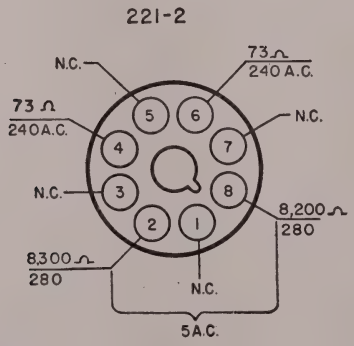
(2) *Resistance measurements.* (*a*) Remove tubes and panel lamps.

(*b*) Disconnect inker assembly plug (189)

(*c*) THRESHOLD and SLOPE controls 10. DISCRIMINATOR on 0.

(*d*) MASTER and MOTOR switches OFF.





NOTE: ⊣⊢ IS SYMBOL FOR FIXED CAPACITOR.

Figure 26. Power Supply No. 1 circuit schematic and voltage and resistance values.

c. Power Supply No. 1 Parts Data.

Ref symbol	Signal Corps stock No.	Name of part and description	Function
164–1	3Z9858–8.12	SWITCH: bat handle; toggle. DPST. Type 20902DN.	MASTER ON–OFF switch.
164–2		SWITCH: bat handle; toggle. DPST. Type 20902DN.	Motor and power supply No. 2 ON-OFF switch.
168		FUSE: 250 volts; 3 amperes. Type 3AG.	For operation on 117–170 volts.
176	2Z9608–1	TRANSFORMER: power. Primary 117–170–210–240 volts; 50–60 cycles; 7 ohms. Secondary: No. 1–460 volts, ct; 60 μa, 153 ohms total, No. 2–5 volts, 3 amperes, 0.13 ohms, shielded. No. 3–5 volts, 3 amperes, 0.13 ohms. No. 4–6.3 volts, ct, 4 amperes, 0.18 ohms total. Type 3697C.	Supplies high voltage ac to rectifier tube (221–2). Supplies filament voltage to tubes (217), (218), (219), (220–1), (220–2), (220–3), (221–1), (221–2). Functions as auto-transformer to furnish 117 volts to (64) and (175) when on 170–210–240 volt operation.
180	3C325–2	CHOKE: filter; 20 henry at 50 ma; 361 ohms. Type 3739A.	Power supply (221–2).
185		RECEPTACLE: flush mounting; male; steel shell; parkerized. Type 61M10.	A-c input for a-c power cord.
188	3Z9825–76	SWITCH: enclosed rotary; 4-position; nonshorting; engraved 117, 170, 210, 240. Type 36.	Switches transformer tap to match line voltage.
211–3		CAPACITOR: fixed; oil-filled; 4 mf +50%, −5%; 600 vdcw. Type TLAD.	Power supply, filter for tube (221–2).
211–4		CAPACITOR: fixed, oil-filled; 4 mf, +50%, −5%; 600 vdcw. Type TLAD.	Power supply, filter for tube (221–2).
213	3DA60–3	CAPACITOR: fixed; paper tubular oil-filled; 0.06 mf +15%, −5%; 600 vdcw. Type TVC.	A-c line bypass.
221–2		TUBE: 5U4G; full-wave rectifier.	Power supply.

28. Power Supply No. 2 (fig. 27)

a. Circuit Repair Features. Power supply No. 2 consists essentially of a power transformer, high-voltage rectifying tube, and filter choke and capacitors. The transformer supplies only high plate voltage and operates only when the MOTOR switch is ON. If tube socket voltage or resistance values are incorrect, parts should be tested individually. See parts list, *c* below, for correct values. To test capacitors 211–1 and 211–2, each must be disconnected to isolate it from the circuit.

b. Voltage and Resistance Measurements. The voltage and resistance measurements shown in figure 27 are made at the pin connections to the tube socket on the underside of chassis. Connect the meter between the pin and chassis to obtain the reading unless otherwise indicated. Make test under the following conditions:

(1) *Voltage measurements.* (*a*) Use 20,000 ohms per volt voltmeter.

(*b*) No signal.

(*c*) THRESHOLD and SLOPE controls on 10. DISCRIMINATOR on 0.

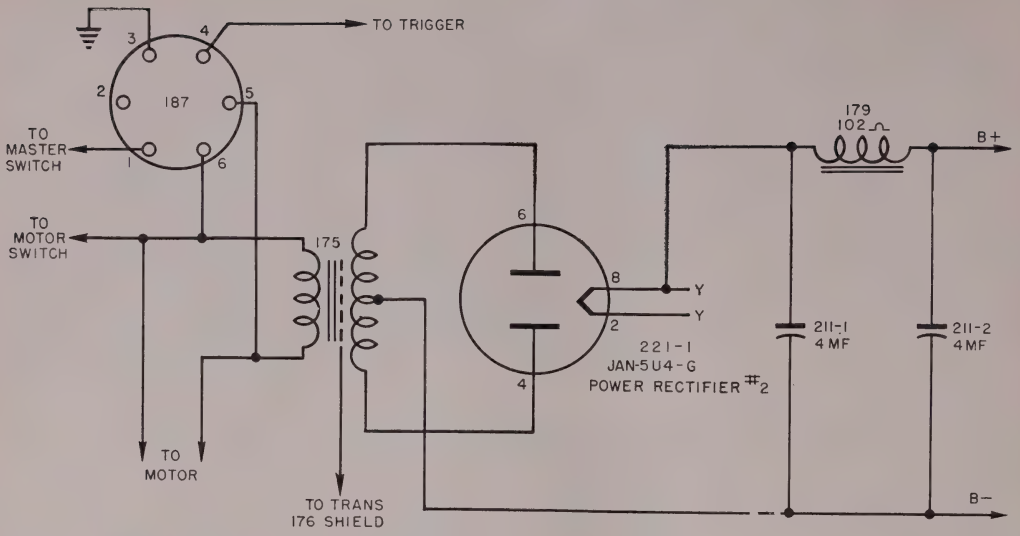
(*d*) MASTER and MOTOR switches ON.

(2) *Resistance measurements.* (*a*) Remove tubes and panel lamps.

(*b*) Disconnect inker assembly plug (189).

(*c*) THRESHOLD and SLOPE controls on 10. DISCRIMINATOR on 0.

(*d*) MASTER and MOTOR switches OFF.



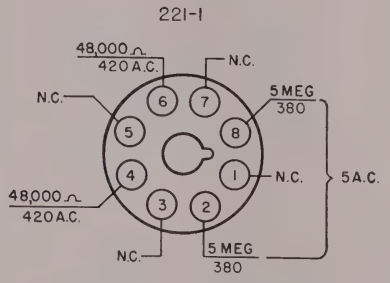


Figure 27. Power Supply No. 2 circuit schematic and voltage and resistance values.

c. Power Supply No. 2 Parts Data.

Ref symbol	Signal Corps stock No.	Name of part and description	Function
175	2Z9612.21	TRANSFORMER: power; primary; 117 volts, 50–60 cycle, 12.8 ohms; secondary: 510 volts, ct, 100 ma, 123 ohms total. Type A3698D.	Supplies high voltage ac to rectifier tube (221–1).
179	3C325–1	CHOKE: filter; 6 henry at 100 ma; 102 ohms. Type 3740A.	Power supply (221–1).
187		SOCKET: tube; 6-prong. Type M1P6TM.	Provides for electronic motor control.
211–1	3DB4–23	CAPACITOR: fixed; oil-filled; 4.0 mf +50%, −5%; 600 vdcw. Type TLAD.	Power supply, filter, tube (221–1).
211–2	3DB4–23	CAPACITOR: fixed; oil-filled; 4.0 mf +50%, −5%; 600 vdcw. Type TLAD.	Power supply, filter, tube (221–1).
221–1		TUBE: 5U4G; full-wave rectifier.	Power supply.

29. Amplifier-Limiter Stage (fig. 28)

a. Circuit Repair Features. The amplifier-limiter circuit either amplifies or limits the input audio frequency. If tube socket voltage or resistance values are incorrect, parts should be tested individually. See parts list, *c* below for correct values. To test parts 178, 206, and 210 each must be disconnected to isolate it from the circuit.

b. Voltage and Resistance Measurements. The voltage and resistance measurements shown in figure 28 are made at the pin connections to the tube socket on the underside of chassis. Connect the meter between the pin and chassis to obtain the reading unless otherwise indicated. Make test under the following conditions:

(1) *Voltage measurements.* (*a*) Use 20,000 ohms per volt voltmeter.

(*b*) No signal.

(*c*) THRESHOLD and SLOPE controls on 10. DISCRIMINATOR on 0.

(*d*) MASTER and MOTOR switches ON.

(2) *Resistance measurements.* (*a*) Remove tubes and panel lamps.

(*b*) Disconnect inker assembly plug (189).

(*c*) THRESHOLD and SLOPE controls on 10. DISCRIMINATOR on 0.

(*d*) MASTER and MOTOR switches OFF.

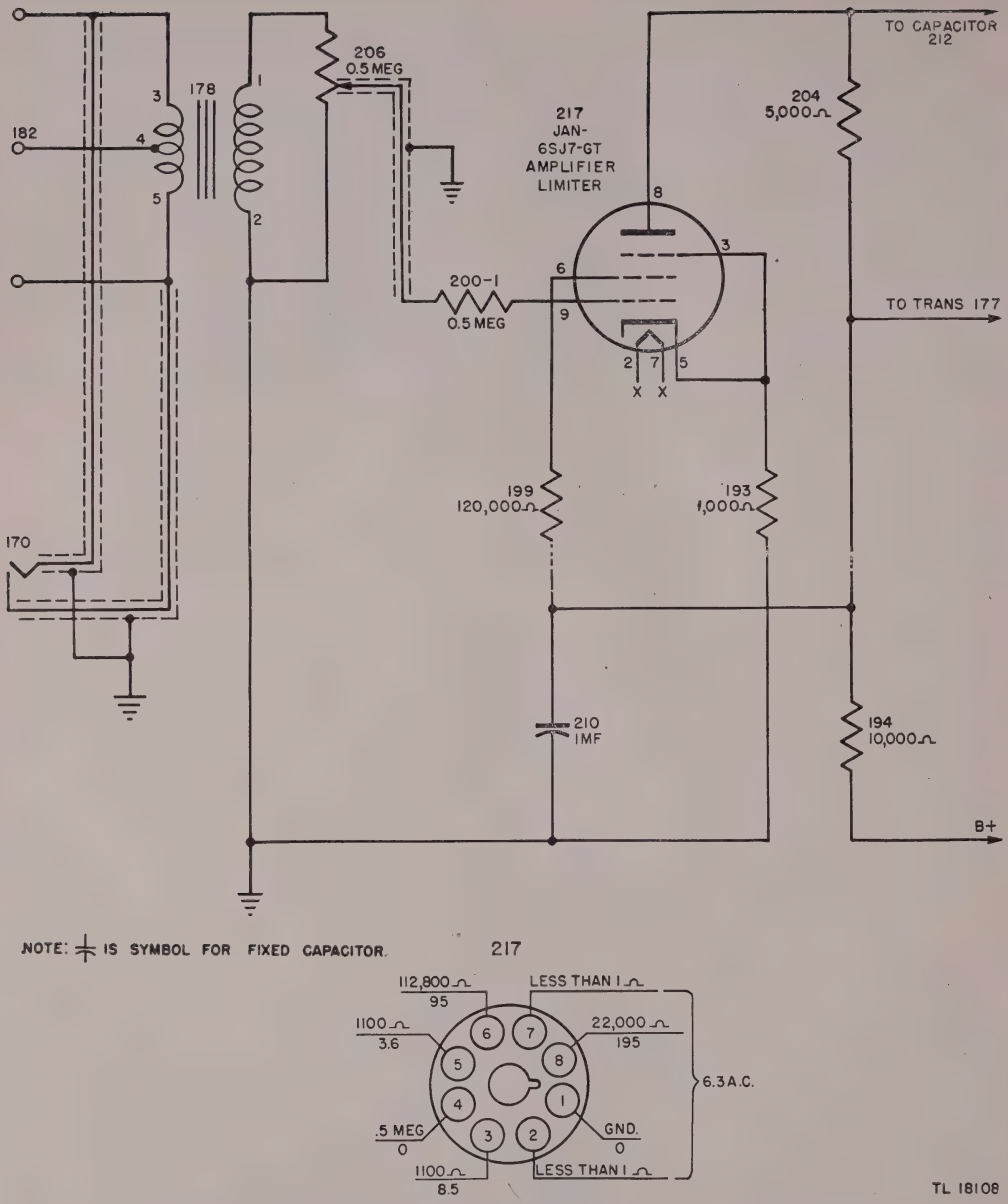


Figure 28. Amplifier-limiter circuit schematic and voltage and resistance values.

c. AMPLIFIER-LIMITER STAGE PARTS DATA.

Ref symbol	Signal Corps stock No.	Name of part and description	Function
170		JACK; open circuit type; shank ⅜–32 thread. Type 1324.	For headphone monitoring.
178	2Z9631.35	TRANSFORMER: input; primary to secondary ratio 1/10. Primary: ct 30 ohms total; secondary: 1,401 ohms. Type 3699D.	Provides inductive coupling between signal input end grid of amplifier-limiter tube.
182		STRIP: terminal; 3 screw terminals. Type 3–50.	Bakelite. Provides for input connections.
193	3Z4525	RESISTOR: insulated carbon; 1,000 ohms ±10%; ½ watt. Type MB½.	Cathode bias tube (217).
194	3Z4529	RESISTOR: insulated carbon; 10,000 ohms ±10%; ½ watt. Type MB½.	Decoupling resistor in tube (217) plate and screen supply.
199	3Z6712–3	RESISTOR: insulated carbon; 120,000 ohms ±10%, ½ watt. Type MB½.	Screen grid of tube (217).
200–1	3Z4533	RESISTOR: insulated carbon; 0.5 meg. ±10%; ½ watt. Type MB½.	Current limiting resistor grid of tube (217).
204	3Z6500–4	RESISTOR: insulated carbon; 5,000 ohms ±5%; ½ watt. Type MB½.	Plate resistor of tube (217).
206	2Z7273	POTENTIOMETER: carbon, audio taper; 500,000 ohms ±10%. Type 37W.	Threshold control.
210	3DB1.6100D	CAPACITOR: fixed; oil-filled; 1 mf, +50% −5%; 600 vdcw. Type DYRT.	Plate and screen grid bypass of tube (217).
217		TUBE: 6SJ7GT; triple grid.	Amplifier and limiter.

30. Signal-Rectifier Stage (fig. 29)

a. CIRCUIT REPAIR FEATURES. The signal-rectifier circuit changes the signal from alternating to direct current. If tube socket voltages or resistance values are incorrect, parts should be tested individually. See parts list, *c* below for correct values. To test parts 177, 212, and 216 each must be disconnected to isolate it from the circuit.

b. VOLTAGE AND RESISTANCE MEASUREMENTS. The voltage and resistance measurements shown in figure 30 are made at the pin connections to the tube socket on the underside of the chassis. Connect the meter between the pin and chassis to obtain the reading unless otherwise indicated. Make test under following conditions.

(1) *Voltage measurements.* (*a*) Use 20,000 ohms per volt voltmeter.

(*b*) No signal.

(*c*) THRESHOLD and SLOPE controls on 10. DISCRIMINATOR on 0

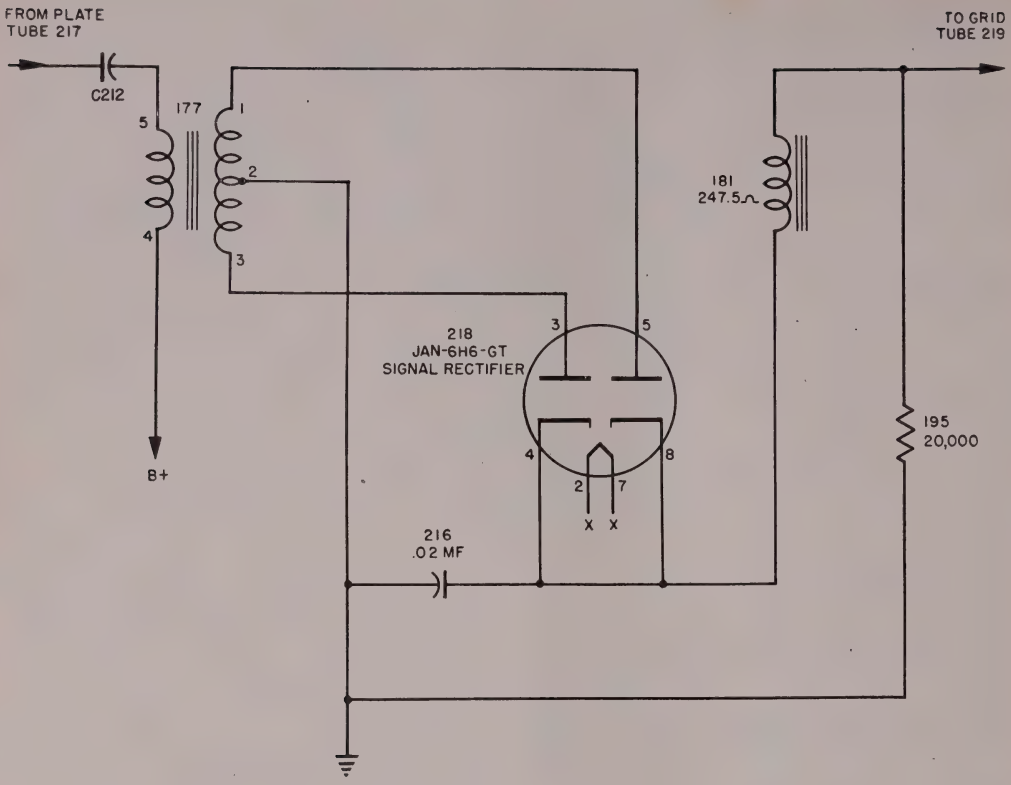
(*d*) MASTER and MOTOR switches ON.

(2) *Resistance measurements.* (*a*) Remove tubes and panel lights.

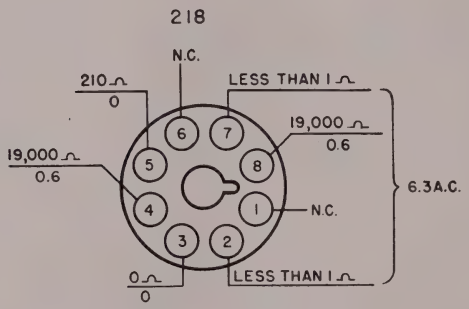
(*b*) Disconnect inker assembly plug (189).

(*c*) THRESHOLD and SLOPE controls on 10. DISCRIMINATOR on 0.

(*d*) MASTER and MOTOR switches OFF.



NOTE: ⊣⊢ IS SYMBOL FOR FIXED CAPACITOR.



TL 18107

Figure 29. Signal-rectifier circuit schematic and voltage and resistance values.

c. SIGNAL-RECTIFIER STAGE PARTS DATA.

Ref symbol	stock No.	Name of part and description	Function
177	2Z9633.3	TRANSFORMER: driver; primary to secondary ratio ½; primary: 313 ohms; secondary; ct, 488.5 ohms total.	Couples limiter tube (217) to signal rectifier tube (218).
212	3DA10–156	CAPACITOR: fixed; paper tubular; oil-filled; 0.01 mf +15%, −5%; 600 vdcw. Type TVC.	Coupling, tube (212) to transformer (177).
216	3DA20–58	CAPACITOR: fixed; oil-filled; paper tubular; 0.02 mf +15%, −5%; 600 vdcw. Type TVC.	Signal filter.
218		TUBE: 6H6GT; twin diode.	Signal rectifier.

31. Trigger Stage (fig. 30)

a. CIRCUIT REPAIR FEATURES. The trigger circuit squares the corners of the d-c voltage waveform. If tube socket voltage or resistance values are incorrect, test parts individually. See parts list, *c* below for correct values. To test parts 197, 201–1, and 203 each must be disconnected to isolate it from circuit.

b. VOLTAGE AND RESISTANCE MEASUREMENTS. The voltage and resistance measurements shown in figure 30 are made at the pin connections to the tube socket on the underside of the chassis. Connect the meter between the pin and chassis to obtain the reading unless otherwise indicated. Make test under following conditions.

(1) *Voltage measurements.* (*a*) Use 20,000 ohms per volt voltmeter.

(*b*) No signal.

(*c*) THRESHOLD and SLOPE controls on 10. DISCRIMINATOR on 0.

(*d*) MASTER and MOTOR switches ON.

(2) *Resistance measurements.* (*a*) Remove tubes and panel lights.

(*b*) Disconnect inker assembly plug (189).

(*c*) THRESHOLD and SLOPE controls on 10. DISCRIMINATOR on 0.

(*d*) MASTER and MOTOR switches OFF.

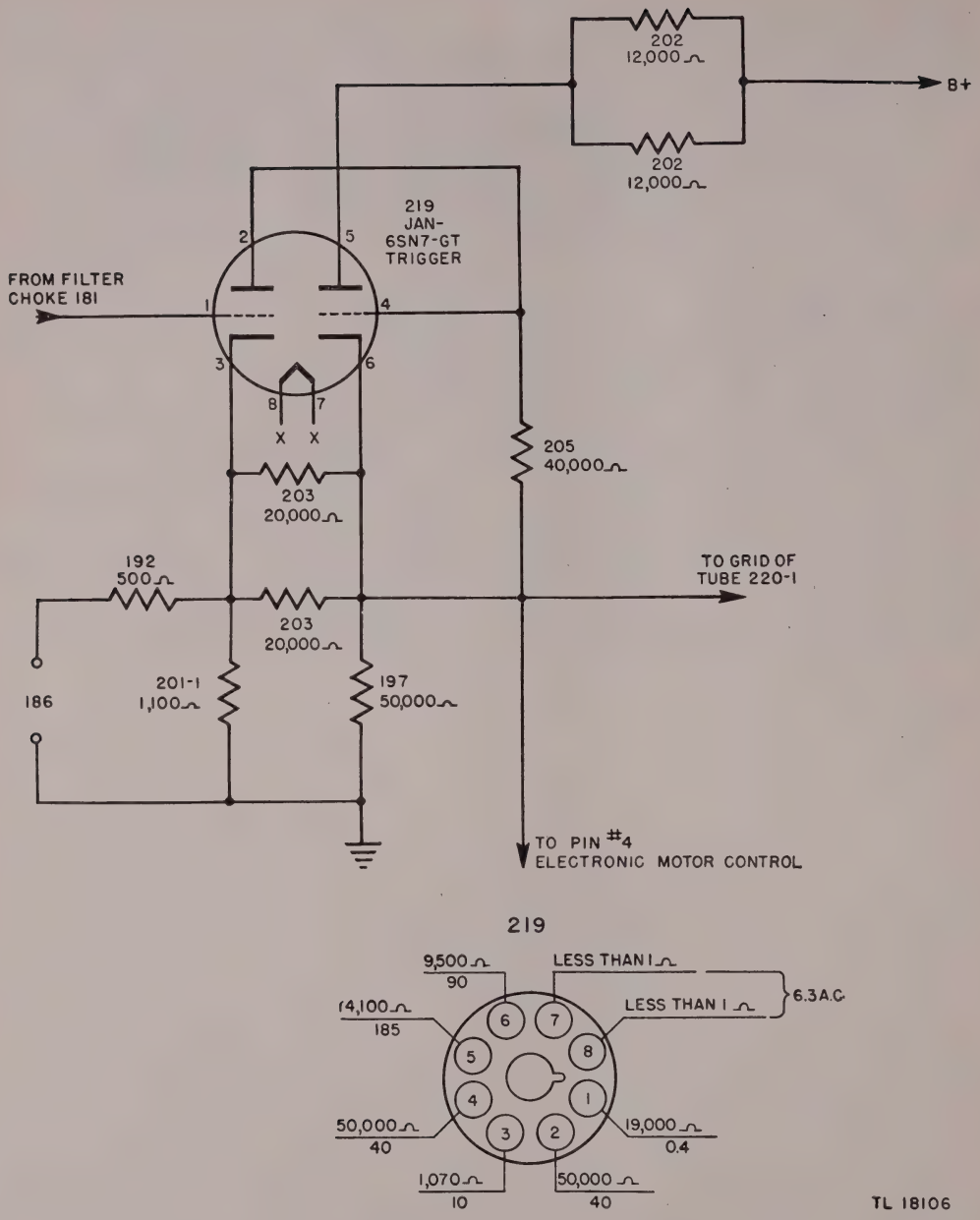


Figure 30. Trigger circuit schematic and voltage and resistance values.

c. TRIGGER STAGE PARTS DATA.

Ref symbol	Signal Corps stock No.	Name of part and description	Function
181	3C325–3	CHOKE: signal; 4 henry at 35 ma dc; 247.5 ohms. Type 3701D.	Removes signal frequency from output of (218).
186		STRIP: terminal; 2-screw. Type 2–50.	Provides for key connections.
192	3Z4524	RESISTOR: insulated carbon; 500 ohms ±10%; ½ watt. Type MB½.	Protects tube (219) from overload when key terminals (186) are used.
195	3Z4476	RESISTOR: insulated carbon, 20,000 ohms ±5%; ½ watt. Type MB½.	Grid resistor. First section of tube (219).
196	3Z6641E5	RESISTOR: insulated carbon, 41,500 ohms ±5%; ½ watt. Type MB½.	Signal voltage divider, output of tube (219).
197	2C4197/46	RESISTOR: insulated carbon; 50,000 ohms ±5%; ½ watt. Type MB½.	Signal voltage divider, output of tube (219).
201–1	3Z6110–5	RESISTOR: insulated carbon; 1,100 ohms ±5%; 1 watt. Type MB1.	Cathode bias, first section of tube (219).
202	3Z6612–3	RESISTOR: insulated carbon; 12,000 ohms ±10%; 1 watt. Type MB1.	Reduces plate voltage to tube (219). (2 resistors in parallel.)
203	3Z6620–5	RESISTOR: insulated carbon; 20,000 ohms ±5%; 1 watt. Type MB1.	Cathode bias, second section of tube (219). (2 resistors wired in parallel.)
205	3Z6640–1	RESISTOR: insulated carbon; 40,000 ohms ±5%; ½ watt. Type MB½.	Combined grid and plate resistor for direct coupled sections of tube (219).
219		TUBE: 6SN7GT; twin triode.	Trigger.

32. Bridge Stage (fig. 31)

a. Circuit Repair Features. The bridge circuit amplifies the d-c pulses and in association with the pen-amplifying stage drives the pen-actuating mechanism. If tube socket voltage or resistance values are incorrect, test parts individually. See parts list, *c* below for correct values. To test parts 198–1, 198–2, and 201–2 each must be disconnected to isolate it from circuit. Resistors 208–1, 208–2, 208–3, and 208–4 are cased together and may be tested by disconnecting each end of resistor and measuring total resistance.

b. Voltage and Resistance Measurements. The voltage and resistance measurements shown in figure 31 are made at the pin connections to the tube socket on the underside of chassis. Connect the meter between the pin and chassis to obtain the reading unless otherwise indicated. Make test under following conditions.

(1) *Voltage measurements.* (*a*) Use 20,000 ohms per volt voltmeter.

(*b*) No signal.

(*c*) THRESHOLD and SLOPE controls on 10. DISCRIMINATOR on 0.

(*d*) MASTER and MOTOR switches ON.

(2) *Resistance measurements.* (*a*) Remove tubes and panel lights.

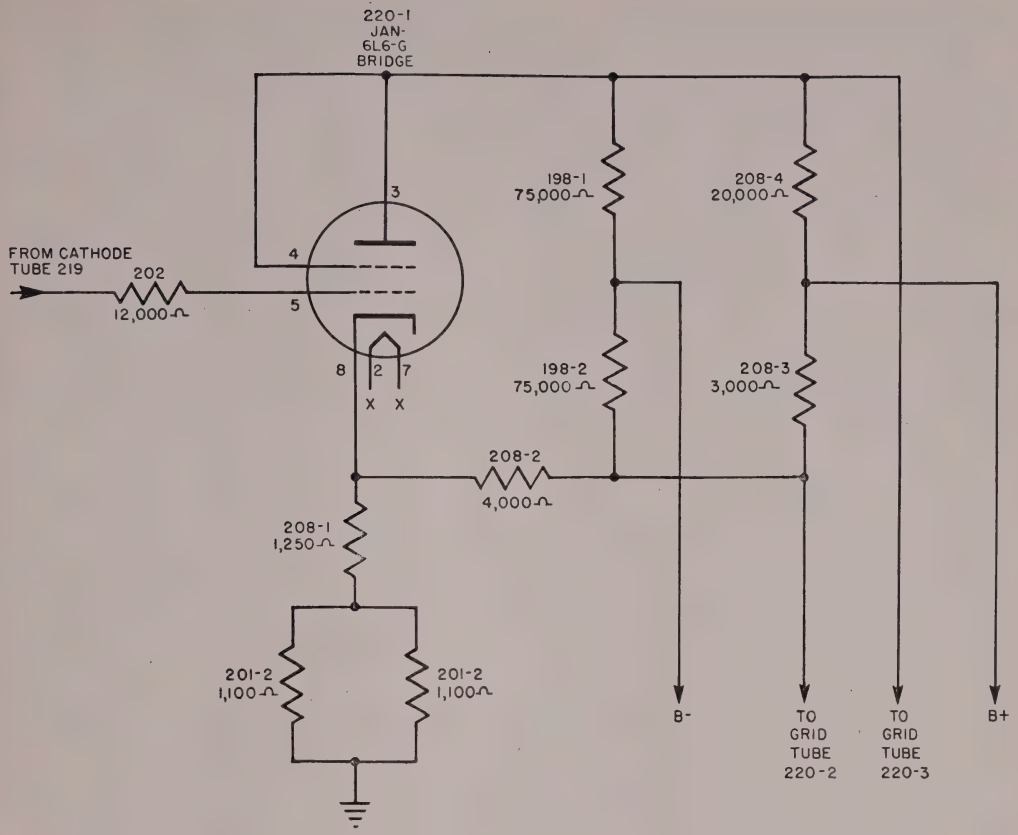
(*b*) Disconnect inker assembly plug (189).

(*c*) THRESHOLD and SLOPE controls on 10. DISCRIMINATOR on 0.

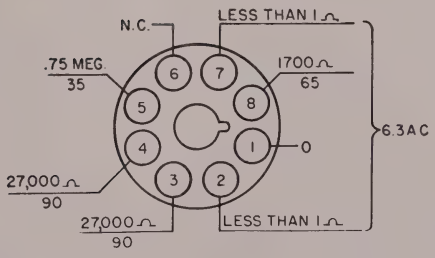
(*d*) MASTER and MOTOR switches OFF.

c. Bridge Stage Parts Data.

Ref symbol	Signal Corps stock No.	Name of part and description	Function
198–1	3Z6675–4	RESISTOR: insulated carbon; 75,000 ohms ±5%; ½ watt. Type MB½.	Grid resistor of tube (220–3).
198–2		RESISTOR: insulated carbon; 75,000 ohms ±5%; ½ watt. Type MB½.	Grid resistor of tube (220–2).
200–2	3Z4533	RESISTOR: insulated carbon; 500,000 ohms ±10%; ½ watt. Type MB½.	Current limiting resistor grid of tube (217).
201–2	3Z6110–5	RESISTOR: insulated carbon; 1,100 ohms ±5%; 1 watt. Type MB1.	Cathode bias for first section of tube (219). (2 resistors in parallel.)
208–1	3Z6620–79	RESISTOR: metal clad; wire-wound; 1,250 ohms ±5%; 4 watts. Cased with 208–2, 208–3; 208–4. Type MMR.	Cathode bias for tube (220–1).
208–2		RESISTOR: metal clad; wire-wound; 4,000 ohms ±5%; 7 watts. Cased with 208–1, 208–3, 208–4.	Bridge circuit arm.
208–3		RESISTOR: metal clad; wire-wound; 3,000 ohms ±5%; 6 watts. Cased with 208–1, 208–2, 208–4.	Bridge circuit arm.
208–4		RESISTOR: metal clad; wire-wound; 20,000 ohms ±5%; 4 watts. Cased with 208–1, 208–2, 208–3.	Bridge circuit arm.
220–1		TUBE: 6L6G; beam power amplifier.	Bridge arm and pen drive amplifier.



220-1



TL 18105

Figure 31. Bridge circuit schematic and voltage and resistance values.

33. Pen-Amplifying Stage (fig. 32)

a. Circuit Repair Features. The pen-amplifying circuit consists of two tubes (220–2 and 220–3) in push pull which in association with the bridge circuit amplifies the d-c pulses and drives the pen-actuating mechanism. If tube socket voltage or resistance values are incorrect, test parts individually. See parts list, *c* below for correct values.

b. Voltage and Resistance Measurements. The voltage and resistance measurements shown in figure 32 are made at the pin connections to the tube socket on the underside of chassis. Connect the meter between the pin and chassis to obtain the reading unless otherwise indicated. Make test under following conditions.

(1) *Voltage measurements.* (*a*) Use 20,000 ohms per volt voltmeter.

(*b*) No signal.

(*c*) THRESHOLD and SLOPE controls on 10. DISCRIMINATOR on 0.

(*d*) MASTER and MOTOR switches ON.

(2) *Resistance measurements.* (*a*) Remove tubes and panel lights.

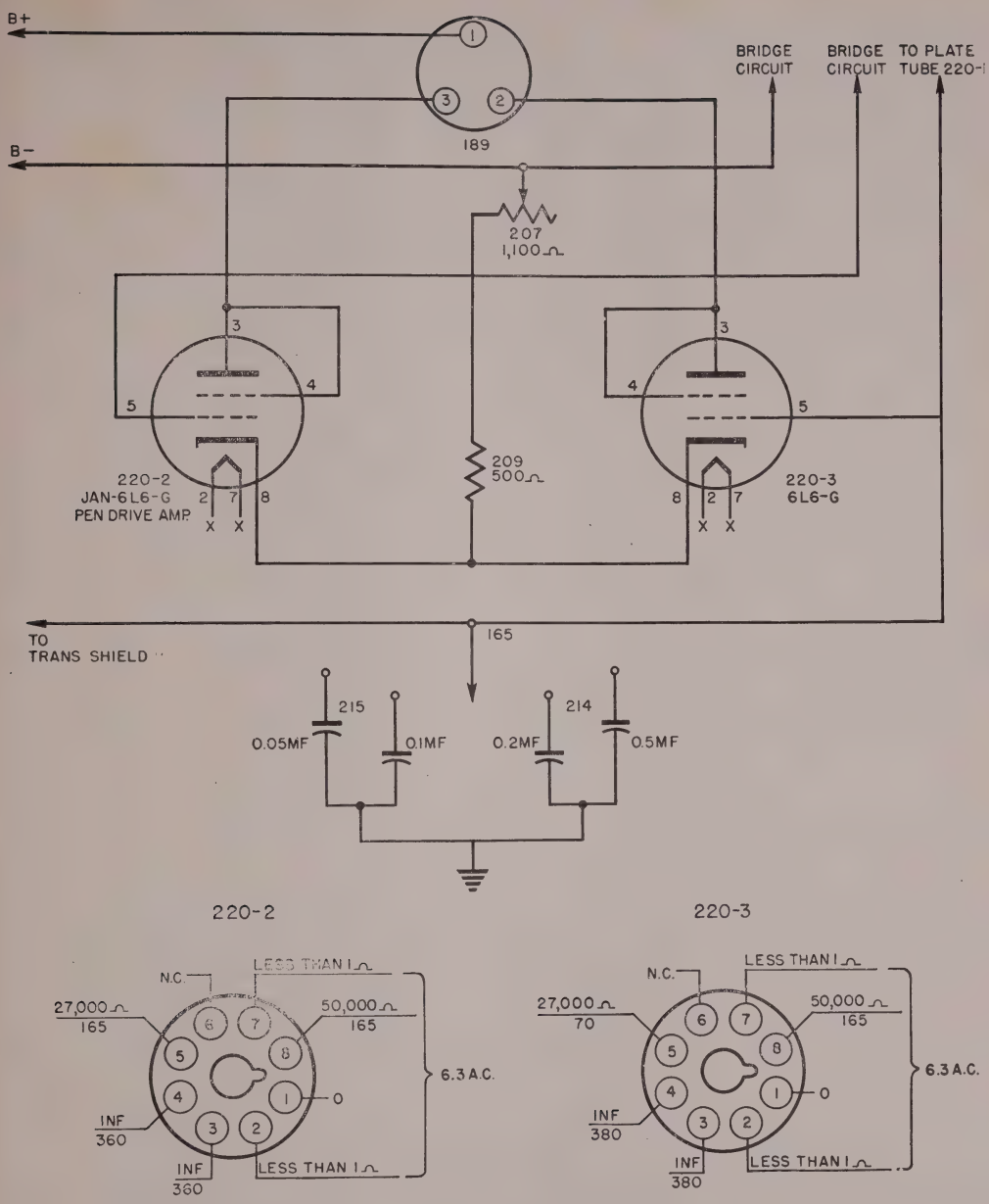
(*b*) Disconnect inker assembly plug (189).

(*c*) THRESHOLD and SLOPE controls on 10. DISCRIMINATOR on 0.

(*d*) MASTER and MOTOR switches OFF.

c. Pen Driving Amplifier Stage Parts Data.

Ref symbol	Signal Corps stock No.	Name of part and description	Function
165	3Z9825–62.22	SWITCH: rotary; 5-position. Type 25058–53.	Discriminator control. Shunts capacitors from plate (220–1) to ground.
189		PLUG: 3-prong; female. Type 203F.	Provides for electrical connections to pen drive assembly.
207	2Z7279–7	POTENTIOMETER: 25 watts; wire-wound; linear taper; 1,100 ohms ±10%. Type PW25.	Slope control.
209	3Z6050–78	RESISTOR: metal clad; wire-wound; 500 ohms ±10%; 10 watts. Type MMR.	Cathode bias, tubes (220–2), (220–3).
214	3DA500–100	CAPACITOR: fixed; dual; oil-filled; 0.5 x 0.2 mf +20%, −10%; 600 vdcw. Type DYRT.	Discriminator circuit, plate tube (220–1).
215	3DA100–155	CAPACITOR: fixed, dual; oil-filled; 0.10 x 0.05 mf +20%, −10%; 600 vdcw. Type DYRT.	Discriminator circuit, plate tube (220–1).
220–2		TUBE: 6L6G; beam power amplifier.	Bridge arm and pen drive amplifier.
220–3		TUBE: 6L6G; beam power amplifier.	Bridge arm and pen drive amplifier.



NOTE: ⫫ IS SYMBOL FOR FIXED CAPACITOR.

TL 18104

Figure 32. Pen-amplifier circuit schematic and voltage and resistance values.

34. Inker Assembly (fig. 33)

a. Repair Features. The inker assembly consists essentially of an electromagnetic coil, pen armature, mechanical linkage, tape rollers, and pen. It translates the electrical impulses from the pen-amplifying tubes to the mechanical recording action of the pen. If parts are worn or broken, see parts list, *b* below for correct dimensions and materials to fabricate new parts.

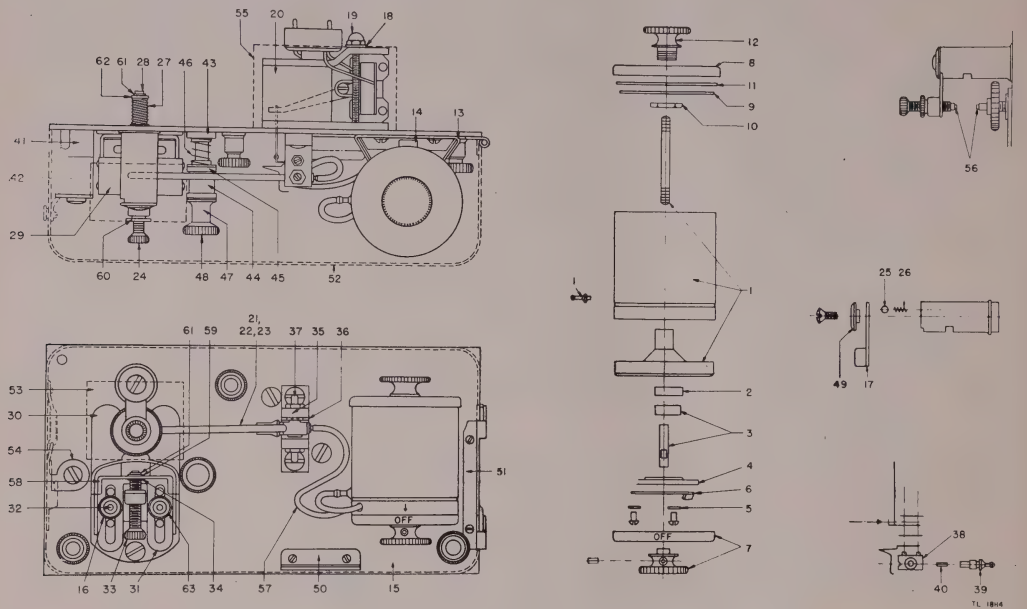


Figure 33. Inker assembly outline drawing.

b. Inker Assembly Parts Data.

Ref symbol	Signal Corps stock No.	Name of part and description	Function
1		BARREL: ink cup; brass; nickel-plt; cylindrical; 2.0 diam x 2.188.	Contains ink supply.
2		ROLLER: ink pump; brass; nickel-plt; cylindrical 0.562 OD x 0.484 ID x 0.175.	Compresses ink hose (57) and controls flow of ink.
3		CAM AND SHAFT: ink pump; brass; nickel-plt; cam; 0.480 diam x 0.175; shaft: 0.1875 diam x 0.875.	Actuates ink pump roller (2).
4		BEARING: control plate; brass; nickel-plt; 1.375 OD x 0.19 ID x 0.093.	Provides bearing for ink pump cam shaft (3), and mounting for ON-OFF locating spring (6).
5		WASHER: lock; bronze; nickel-plt; No. 3. Type 1903.	Used on screws securing ON-OFF locating spring to control plate (4).
6		SPRING: ON-OFF locating; phosphor-bronze; nickel-plt; semicir; 1.25 OD x 0.874 ID x 0.015 flat strip.	Locates position of ON-OFF knob (7).
7		KNOB: ON-OFF; brass; nickel-plt; 2.0 diam x 0.628 engraved.	Controls and indicates position of ink pump.
8		COVER: ink cup; brass; nickel-plt; 2.15 OD x 2.05 ID x 0.63.	Covers top of ink cup barrel (1).
9		WASHER: gasket retainer; brass; nickel-plt; 1.80 OD x 0.38 ID x 0.05.	Holds gasket in place in ink cup cover (8).
10		NUT: 3/8–32 hex. x 3/32 brass; nickel-plt.	Secures gasket (11) and gasket retainer washer to ink cup cover (8).

Ref symbol	Signal Corps stock No.	Name of part and description	Function
11	4A1953/G2	GASKET: ink cup cover; "Hycar"; 2.050 OD x 0.400 ID x 0.030.	Providing ink seal for ink cup cover (8).
12		KNOB: ink cup cover; brass; nickel-plt; knurled; 0.87 OD x 0.66; tapped for 8–32 screw.	Provides for tightening or loosening of ink cup cover (8).
13		BRACKET: ink cup; brass; nickel-plt; 2.0 x 2.375.	Mounts ink cup on panel (15).
14		SPRING: ink cup positioning; phosphor-bronze; nickel-plt; 0.375 x 0.016 x 1.50.	Holds ink cup at desired level.
15		PANEL: inker; brass; nickel-plt; 4.375 x 0.125 x 8.0.	Mounts inker parts.
16		EYELET: brass; nickel-plt, barrel: 0.105 OD. Flange: 0.2" OD. Type 751.	Secures ink cup positioning spring (14) to ink cup bracket (13).
17		ARM AND FITTING: pen adjusting; brass; nickel-plt; 0.50 x 0.314 x 1.34. Fitting threaded for 8–40 screw.	Provides for pen adjustment.
18		WASHER: fiber; ⅜ OD; No. 8	Used on pen drive mounting screws.
19		NUT: acorn; brass; black oxidized; 5/16 x 8–32.	Secures pen drive cover (8).
20		DRIVE UNIT: pen, electromagnetic; pole pieces and yoke; soft iron parkerized. Magnets: Alnico. 1.75 x 1.63 x 2.44. Coil: 300 ohm, ct with 3-terminal male connector Type "B".	Drives pen arm.
21	4A1953/P8	PEN: wide line	For wide line recording.
22	4A1953/P7	PEN: medium line	For medium line recording.
23	4A1953/P6	PEN: fine line	For fine line recording.
24	4A1953/S6	SCREW: pen adjusting; front; brass; nickel-plt; 0.164 diam x 1.062 with knurled head 0.375 diam; 8–40 thread.	Regulates pen stroke.
25		BALL: steel; ⅛; grade "A"	Holds adjusting arm (17) in desired position.
26		SPRING: pen adjusting arm; steel music wire, zinc-plt. 0.125 diam x 0.250 x 0.016 diam stock.	Forces ball (25) into dimple on adjusting arm (17).
27		SPRING: pen stop; steel; nickel-plt; 0.30 diam x 0.88 x 0.032 stock.	Holds rear pen adjusting screw (28) at desired setting.
28	4A1953/S5	SCREW AND WHEEL: pen adjusting rear; brass; nickel-plt. Screw: 0.165 diam x 1.155; 8–40 thread. Wheel: knurled 0.875 diam x 0.25.	Regulates pen stroke.
29	4A1953/P9	ANVIL: tape; stainless steel; U-shaped; 0.75 x 0.59 x 1.439 x 0.063 stock.	Provides smooth recording surface.
30		BRACKET AND FITTING: anvil mounting; brass; nickel-plt. Bracket: 1.566 x 0.184 diam x 3.0. Fitting: 0.375 diam x 0.324, tapped for 8–40 screw.	Mounts tape anvil (29).
31		SLIDE: anvil adjusting; brass; nickel-plt; 1.439 x 1.187 diam x 1.55.	For anvil adjustment.
32		EYELET: brass; nickel-plt; ⅛ OD x 3/16. Type A557.	Secures anvil (29) and adjusting slide (31) to anvil mounting bracket (30).
33		SCREW: anvil adjusting; brass; nickel-plt; 0.164 diam x 1.425 with knurled head 0.375 diam; 8–40 thread.	Regulates height of anvil (29).
34		WASHER: spring; phosphor bronze; nickel-plt: 5/16 OD 7/16 ID x 0.013. Type 3700–3.	Used on anvil adjusting screw (33).
35		BLOCK: pen mounting; brass; nickel-plt; 1.0 x 0.50 diam x 1.688.	Mounts pivot block (38).
36		SPRING: pivot friction; beryllium copper; silver-plt; 0.50 x 0.340 diam x 0.625 x 0.0126 stock.	Provides for friction adjustment between pivot block and pen mounting block.
37	4A1953/S4	SCREW: pen pivot; beryllium copper; 0.125 diam x 0.50; pointed at one end.	Provides pivot adjustment.
	6L3105–40	NUT: pivot screw; brass; nickel-plt; 5/16 x 5–40 thread.	Locks pen pivot screw (37).
38	4A1953/B5	BLOCK: pivot assembly; monel metal; 0.312 x 0.281 diam x 0.484. Tapped for 10–40 thread.	Pivots pen arm.
39		FITTING: ink hose; monel metal; flange diam 0.250 x 0.561, 10–40 thread.	Connects ink hose to pivot block.
40		GASKET: pen; 0.335; No. 12 transflex tubing.	Seals pen inside pivot block (38).

Ref symbol	Signal Corps stock No.	Name of part and description	Function
41		SHAFT: plain tape roller; steel; nickel-plt; 0.562 diam x 1.260, tapped at both ends for 8–32 thread.	Mounts plain tape roller (42).
42		ROLLER: plain tape; brass; nickel-plt; 0.562 OD x 0.219 ID x 0.75.	Receives tape from anvil (29).
43		SHAFT: adjustable tape roller; steel; nickel-plt; 0.562 diam x 1.437, tapped at large end for 8–32 and at small end for 8–40 thread.	Mounts adjustable roller (44).
44		ROLLER: adjustable tape; brass; nickel-plt; 0.562 OD x 0.282 ID x 0.625.	Positions tape on anvil (29).
45		BUSHING: adjustable tape roller; steel; nickel-plt; 0.562 diam x 0.744.	Allows adjustable roller (44) to slide freely on shaft (43).
46		SPRING: adjustable tape roller; steel wire; nickel-plt; 0.406 diam x 0.875 x 0.032 stock.	Takes up roller and play.
47		COLLAR: adjustable tape roller; brass; nickel-plt; 0.562 OD x 0.219 ID x 0.442.	Permits adjustable tape roller (44) to turn.
48		SCREW: tape roller adjusting; brass; nickel-plt; 0.562 diam x 0.937; knurled head; 8–40 thread.	Positions adjustable tape roller (44).
49		WASHER: pen adjusting arm; brass; nickel-plt; 0.625 OD x 0.17 ID x 0.156.	Secures pen adjusting arm (17).
50		ANGLE: inker cover guide; steel; nickel-plt; 0.34 x 0.50 diam x 1.5 x 0.036 stock.	Positions inker cover (52).
51		HALF-HINGE: inker panel; steel; nickel-plt; 2.8 x 0.186 diam x 0.467.	Hinges inker cover (52) to panel (15).
52		COVER: inker and hardware; steel; parkerized; wrinkle enamel; 4.375 x 2.5 diam x 8.0.	Encloses inker unit.
53		WINDOW: inker cover; ethocel; 2.43 x 4.31 x 0.021 stock.	Permits inspection of pen operation.
54		PLATE: latch striker; steel; nickel-plt; 0.563 x 0.665 x 0.030 stock.	Latches inker cover (52).
55		COVER: pen drive unit; brass; black enamel; 2.0 x 2.0 x 2.63 x 0.016 stock.	Incloses pen drive unit (20).
56		STOP: pen, viscoloid; 0.094 diam x 0.188.	Cushions pen adjusting screws (24) and (28).
57	4A1953/B7	HOSE: ink; transflex tubing; No. 14; 7.50 long.	Carries ink from ink cup to pivot block hose fitting (39).
58	4A1953/T7	BRACE: Tape anvil adjusting; brass; nickel-plt; U-shaped; 0.376 diam x 1.062 x 1.311 x 0.064 stock.	Connects tape anvil (29) to adjusting screw (33).
59		WASHER: brass; nickel-plt; 0.281 OD x 0.119 ID x 0.025.	Used on anvil adjusting screw (33).
60		NUT: pen adjusting; brass; nickel-plt; knurled; 0.50 diam x 0.110; tapped for 8–40 screw.	Locks pen adjusting screw (24).
61		WASHER: "O" phosphor-bronze; nickel-plt; 0.25 OD x 0.074 ID x 0.025.	Fastens adjusting screw (33) to anvil brace (58) and fastens spring collar (62) on rear adjusting screw (28).
62		COLLAR: rear pen adjusting screw; brass; nickel-plt; 0.30 x 0.111 ID x 0.110.	Used on rear adjusting screw (28).
63		WASHER: spring; spring bronze; nickel-plt; 0.438 OD x 0.156 ID x 0.016 stock.	Provides friction mounting for anvil adjusting slide (31).

c. REPLACEMENT OF INKER ASSEMBLY PARTS.

(1) *Replacement of electromagnetic coil (20).*

(*a*) *Removal.*

1. Remove cover from pen drive unit.
2. Unsolder copper link from armature of pen drive unit.
3. Remove ink cup from bracket.
4. Remove ink cup bracket (13) e posing one of the three screws holding drive unit to panel.
5. Remove the three drive unit mounting screws and remove coil from inker panel.

(*b*) *Reassembly.*

1. Mount new coil on inker panel.
2. Screw up pen stops to hold pen and pivot block firmly and parallel to panel.
3. Shunt across poles of pen drive unit with soft iron bar so that drive arm assumes a center position. This may also be accomplished by inserting a shim between armature and coil.
4. Set adjusting screw on top side of drive unit so that screw slot is parallel to panel. (See fig. 34.)
5. Resolder link to drive arm, using just enough solder to fill completely the slit in the link.

(*c*) *Pen drive adjustment.*

1. Remove shunt from magnetic poles of pen drive.
2. Replace ink assembly.
3. Connect recorder to signal input and thread tape.
4. With SLOPE control at zero, and pen stops set for $\frac{3}{16}$- to $\frac{1}{4}$-inch swing, operate the recorder.
5. Turn pen drive adjustment screw (fig. 34) first to left, then to right, so that pen will travel first along one edge, then along the other.
6. Set screw so that pen is midway between these two positions.

Note. This adjustment becomes more critical as recording speed increases.

(2) *Replacement of pivot block.* (*a*) *Removal.*

1. Remove pen, pen pivot screws (37), and ink tube from pivot block.
2. Remove pen drive unit cover.
3. Unsolder link from drive unit armature.

(*b*) *Reassembly.*

1. Renew pivot block assembly, exercising care not to bend copper link.
2. Replace pen, pivot screws, and ink hose.
3. Reset pivot screws to allow pivot block to move freely but without up and down movement. (If points of pivot screws are worn, replace them.)
4. If new pivot screws have been installed, swing pen arm back and forth to "seat" pivot in block. Then recheck adjustments and reset if there is any vertical movement. Retighten lock nuts securely after making adjustment.
5. Resolder link to armature as outlined in *c*(1) (*b*) above.

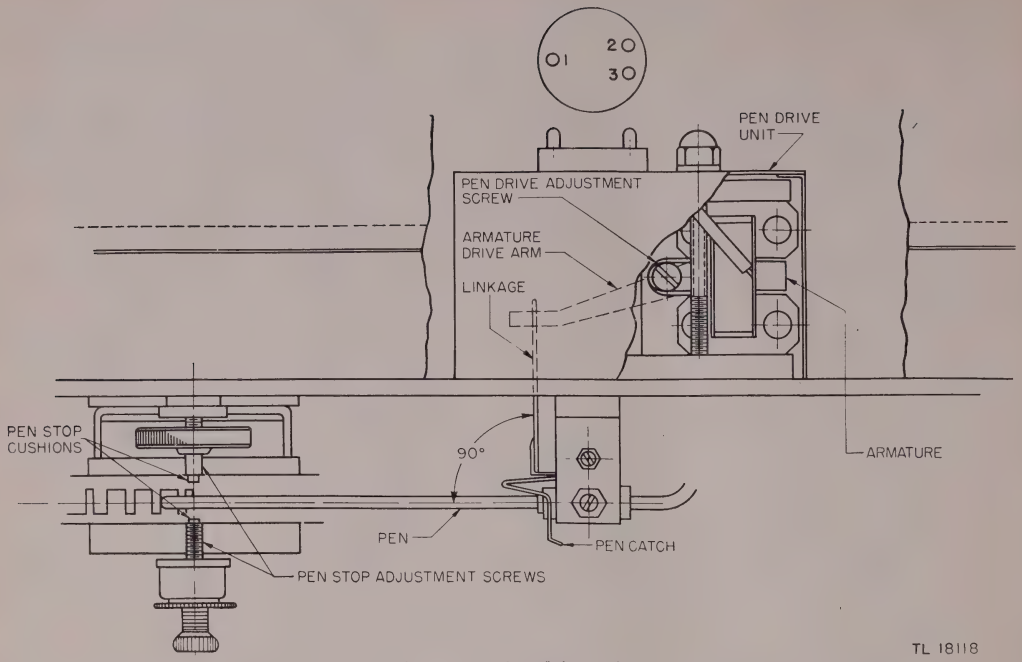


Figure 34. Pen drive unit.

35. Motor Drive Assembly (fig. 35)

a. Repair Features. The motor drive assembly includes the motor and variable speed mechanism for driving the roll that pulls the tape through the recorder. Maintenance of this unit should include the repair or replacement of all defective parts. If parts are worn or broken see parts list, *b* below which give dimensions, materials, and finish of each part in the motor drive assembly. See *c* below for procedure of replacing motor and other parts of assembly. If motor will not operate with the application of 110 volts a-c to the terminals it should be replaced. If the gear reduction unit of the motor is defective the entire motor should be replaced as a unit.

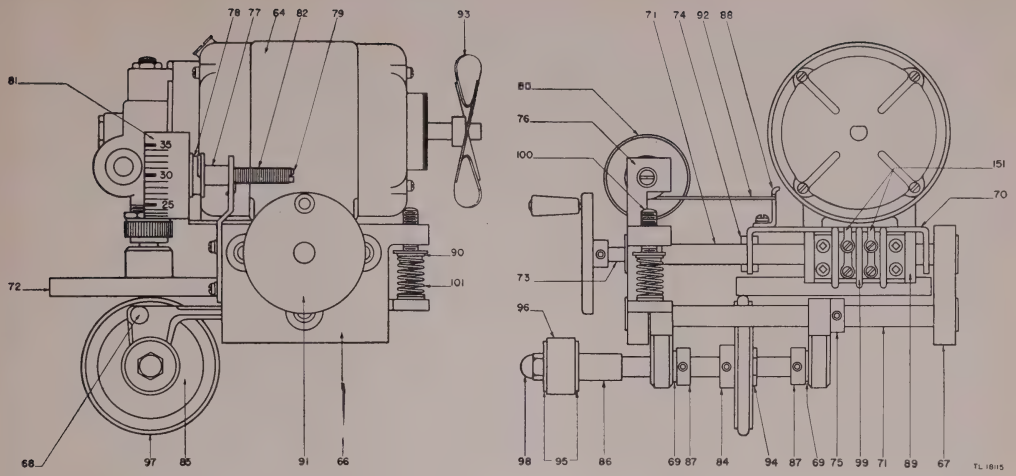


Figure 35. Motor arive assembly outline drawing.

b. MOTOR DRIVE ASSEMBLY PARTS DATA.

Ref symbol	Signal Corps stock No.	Name of part and description	Function
64	3H3100A02–1	MOTOR: split phase; 60-cycle; 115 volts; 0.85 amp; 1/50 hp; 1,725 rpm; ventilated ball-bearing; with 18:1 worm gear reducer; 7.09 x 3.56 diam frame. Type NS1–12R.	Powers tape puller.
65		WASHER: lock; steel; parkerized; external-internal tooth; 0.50 OD; No. 8 Type 4008–14.	Used on motor holding screws.
66		END PLATE: tape puller; front; cast iron; parkerized and stained; 2.125 x 0.860 x 3.75.	Mounts motor (64).
67		END PLATE: tape puller; rear; cast iron; parkerized and stained; 2.125 x 0.406 x 3.0.	Mounts motor (64).
68		BRACKET: tape drive shaft; cast iron; parkerized and stained; 3.75 x 1.625 x 6.5.	Mounts tape drive shaft (86).
69		BEARING: bronze; oilite; 0.563 OD x 0.314 ID x 0.50. Type F–437.	Provides bearing for tape drive shaft bracket (68).
70		BASE: motor mounting; steel; parkerized and stained; U-shaped, 3.0 x 0.875 diam x 3.25 x 0.125 stock.	Provides carriage for motor (64).
71		ROD: motor mounting base; stainless steel tubing; 0.375 OD x 6.0 x 18 gauge stock.	Pivots tape drive shaft bracket (68) and provides slide for motor mounting base (70).
72	4A1953/D6	DISC; friction drive; cast iron; parkerized and enameled; 3.63 diam x 0.875.	Drives neoprene ring (97).
73		SCREW: tape speed control; steel; parkerized and oiled; 0.375 diam x 6.77; ⅜–16 thread.	Shifts position of motor mounting base on base rods (71).
74		NUT: tape speed control; brass; nickel-plt; 0.625 x 0.750 x 0.313; tapped for ⅜–16 screw.	Used on tape speed control screw to move motor mounting base (70).
75		COLLAR: steel; parkerized and stained; 0.625 OD x 0.378 ID x 0.250; tapped for 8–32 set screw.	Used on motor base rods (71) as carriage stop.
76		BRACKET: indicator dial; steel; parkerized and stained; 0.750 x 2.56 x 0.281 x 0.94 stock.	Mounts indicator dial assembly.
77		BEARING: indicator dial; brass; nickel-plt; 0.375 OD x 0.187 ID x 0.550.	Provides bearing for indicator dial shaft (79).
78		PULLEY: indicator dial; steel; parkerized; oiled; 0.812 diam x 0.336; drilled for 0.140 shaft; tapped for 4–40 set screw.	Provides dial cord take-up.
79		SHAFT: indicator dial; steel; parkerized; oiled; 0.250 diam x 2.17. One end threaded 6–32.	Supports indicator dial assembly.

Ref symbol	Signal Corps stock No.	Name of part and description	Function
80		SUPPORT: indicator dial; steel; parkerized; stained; 1.5 x 0.50 x 1.5.	Mounts indicator dial (81).
81		DIAL: indicator; white cellulose acetate; 0.81 x 5.14 x 0.020.	Indicates tape speed.
82		SPRING: indicator dial; steel; zinc-plt; 0.312 diam x 0.937 x 0.027 stock.	Provides dial cord take-up tension.
83		WASHER: lock; steel; parkerized; internal tooth; 5/8 OD x 0.50. Type 1224–2.	Used on driven wheel assembly, and used on toggle switches.
84		HUB: driven wheel; steel; parkerized; stained; 0.750 OD x 0.314 ID x 0.75. One end threaded 15/32–32.	Provides bearing for driven wheel assembly.
85		DISC: driven wheel; steel; parkerized and stained; 2.312 OD x 0.470 ID x 0.184 x 0.059 stock.	Supports neoprene ring (97).
86		SHAFT AND SLEEVE: tape drive; steel; parkerized; oiled; 0.437 diam x 5.343. One end threaded 10–32.	Mounts driven wheel assembly and tape puller roll (96).
87		COLLAR: tape drive shaft; steel; parkerized and stained; 0.562 OD x 0.315 ID x 0.250. Tapped for 8–32 set screw.	Positions tape drive shaft (86).
88		BRACKET: anchoring dial cord; steel; parkerized; stained; 0.719 x 1.68 x 0.375 x 0.036 stock.	Provides anchor for dial cord on motor mounting base.
89		BRACKET: terminal mounting block; steel; parkerized; stained; L-shaped; 1.125 x 0.875 diam x 2.0 x 0.032 stock.	Supports terminal block.
90		COLLAR: drive tension adjustment; steel; parkerized; stained; 0.625 diam x 0.250 with 0.250 diam hole in flanged end.	Provides guide for tension spring.
91		KNOB: tape speed control; disc; steel, parkerized, wrinkle enamel; handle: (117) Bakelite; 2.15 diam x 1.44 diam, including handle and hub.	Turns tape speed control screw.
92	4A1953/C5	CORD: dial; linen cable; 6.0 long.	Moves dial to indicate tape speed.
93		FAN: ventilating; steel; parkerized; stained; four blades; 3.0 diam x 0.56 x 0.024 stock.	Provides forced circulation of air inside of cabinet.
94		NUT: hex; steel; parkerized; 15/32–32 thread; 0.125 long.	Fastens driven wheel discs together.
95		WASHER: tape drive roll; steel; parkerized; 0.94 OD x 0.25 ID x 0.062.	Supports tape drive roll (96).
96	4A1953/R5	ROLL: tape drive; gum rubber; 1.0 diam x 0.50; 0.25 hole. Type K88.	Pulls paper tape.
97	4A1953/R7	RING: driven; Neoprene; 2.375 OD x 0.250 round stock.	Provides contact with friction drive disc (72).
98		NUT: acorn; brass; black; nickel-plt; 10–32 thread; 0.375 long.	Secures tape drive roll (96).
99		BLOCK: terminal; molded bakelite; 0.50 x 1.125 x 2.125. Type 2–141.	Provides electrical connection to motor (64).
100		SCREW: drive tension adjusting; steel; parkerized; 1/4–20 thread; 1.0 long.	Varies compression of drive tension spring (101).
101		SPRING: drive tension; steel; zinc-plt; 0.44 diam x 2.0 x 0.047 stock.	Provides tension for friction drive.
151		LUG: solder; brass; tin-plt; 0.31 x 0.81; size 6. Type 2107.	Various electrical connections to chassis.

c. DISASSEMBLY AND REPAIR OF MOTOR DRIVE ASSEMBLY. (1) *Disassembly.* With an Allen head wrench (0.078-inch head) loosen three set screws holding motor mounting base rods (71) in each end plate (66 and 67). End plates can then be removed and tape speed control screw (73) and nut (74) may be taken out. To replace motor, remove four screws in motor mounting base (70) and unsolder leads from motor to terminal block (99).

(2) *Motor unit disassembly.* (*a*) Loosen set screw in fan hub and remove fan from shaft.

(*b*) Remove four screws holding end of motor (fan end) to motor housing. Pull motor end from housing.

(*c*) Remove three screws holding gear reduction unit to motor housing.

(*d*) Pull motor armature from motor. (See fig. 36.)

(*e*) To inspect bearings, remove bearing plates from each end of motor.

(*f*) Reverse procedure to reassemble.

SECTION IX

SUPPLEMENTARY DATA

36. Unclassified Parts

a. GENERAL. Several working parts on the recorder cannot be conveniently grouped in any electrical stage or as parts of the inker or motor drive assemblies. If repairs or replacements of any of these parts is necessary, data on each part will be found in the unclassified parts list, *b* below.

b. UNCLASSIFIED PARTS DATA.

Ref symbol	Signal Corps stock No.	Name of part and description	Function
102		BUSHING: pressure roller cam; steel; parkerized; oiled; 0.50 OD x 0.315 ID x 0.25.	Provides bearing for pressure roller camshaft (103).
103		CAM AND SHAFT: pressure roller; steel; parkerized; oiled; 3.5 x 2.875 x 4.375.	Disengages driven wheel assembly from friction drive disc (72).
104		ARM AND SHAFT: pressure roller; steel; parkerized and oiled; arm: 1.84 x 0.50; shaft: 1.44 x 0.185; one end threaded 6–32.	Mounts pressure roller (106).
105		NUT: acorn; steel; nickel-plt; 0.3125 x 0.625; 6–32 thread.	Secures pressure roller (106).
106		ROLLER: pressure; brass; nickel-plt; 0.630 OD x 0.189 ID x 0.874.	Holds tape against drive roll (96).
110		WASHER: steel; nickel-plt; 0.375 OD x 0.172 ID x 0.032.	Used on tape roller screws.
133		STUD: tape guide roller mounting; steel; parkerized; oiled; 0.562 diam x 1.314; tapped at both ends for 8–32 screw.	Mounts tape guide rollers (134).
134		ROLLER: tape guide; brass; nickel-plt; 0.562 OD x 0.220 ID x 0.625.	Guides and relieves friction on moving tape.
136		ROLLER: tape guide take-up; brass; nickel-plt; 0.562 OD x 0.220 ID x 0.625.	Receives tape from tape anvil.
137		BRACKET: tape guide roller; steel; parkerized; wrinkle enamel; 1.5 x 1.188 x 0.56 diam.	Supports tape guide roller shaft (138) on panel.
138		SHAFT: tape guide roller; steel; parkerized; oiled; 0.28 diam x 0.77 tapped at one end for 8–32 screw.	Mounts tape guide rollers on roller brackets (126) and (137).
140		WASHER: guide roller shaft; steel; parkerized; oiled; 0.562 OD x 0.166 ID x 0.059.	Provides bearing surface between tape guide roller and roller bracket.
154		BASE AND PIN; dust collector; cast iron; parkerized; wrinkle enamel; 0.437 x 3.5 diam x 1.5.	Mounts half covers on dust collector.
155		PIN: dust collector pivot; steel; parkerized; oiled; 0.245 diam x 1.87.	Pivots dust collector cover (157).
156		COVER: dust collector; fixed half; cast iron; parkerized; wrinkle enamel; 1.5 x 1.16 diam x 1.969.	Mounts fixed brush.
157		COVER: dust collector; moveable half; cast iron; parkerized; wrinkle enamel; 1.5 x 1.16 diam x 1.969.	Mounts moveable brush and permits threading of tape.
158		CLAMP: dust collector brush; steel; parkerized; stained 0.50 x 0.52 diam x 0.16 x 0.037 stock.	Fastens brushes in dust collector.
159	4A1953/B6	BRUSH: dust collector; mane hair; metal bound; 0.75 x 0.25 diam x 1.12.	Removes tape lint.

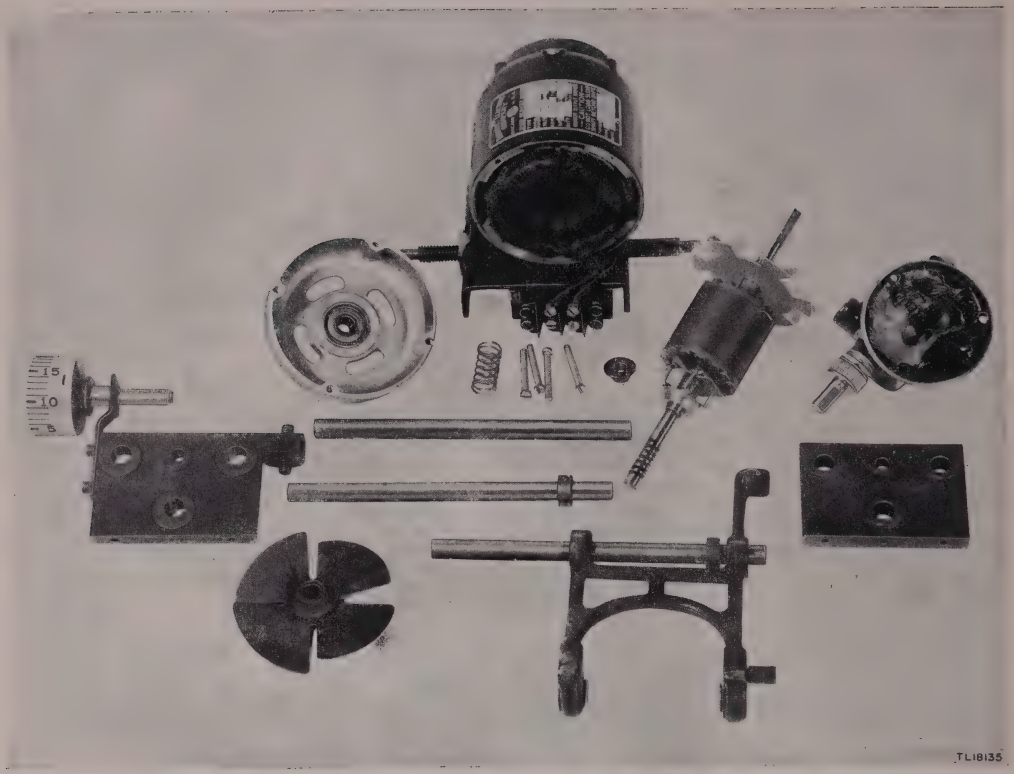


Figure 36. Motor unit disassembly.

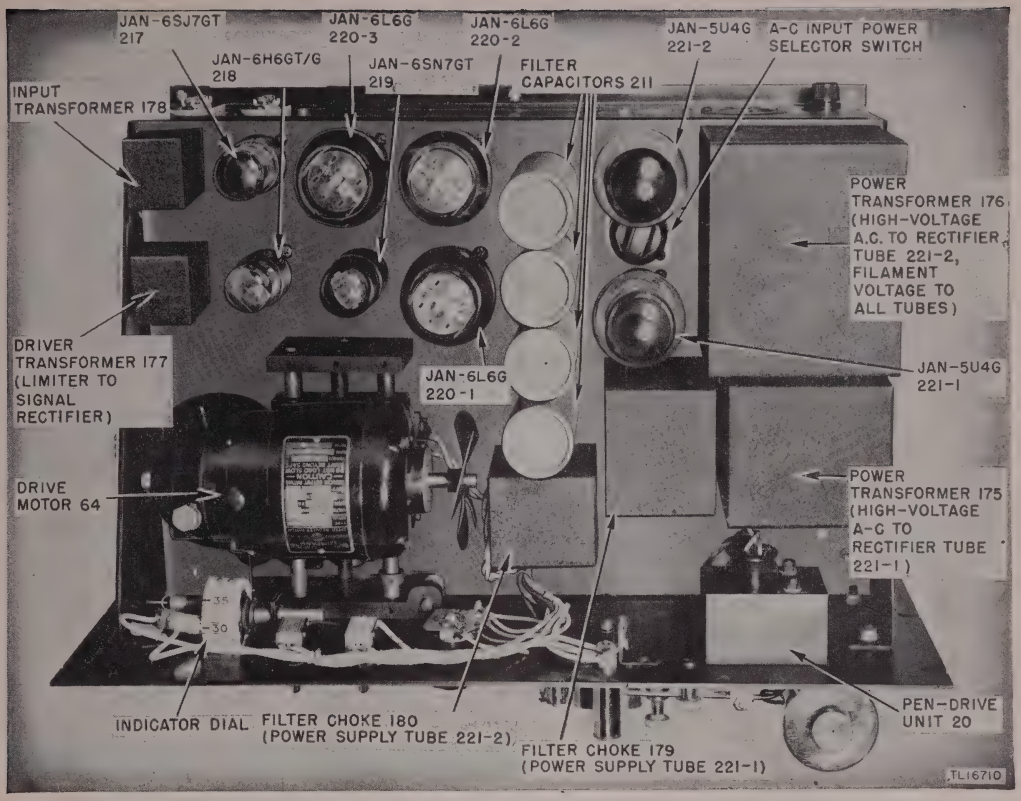


Figure 37. Top view of recorder with parts reference numbers.

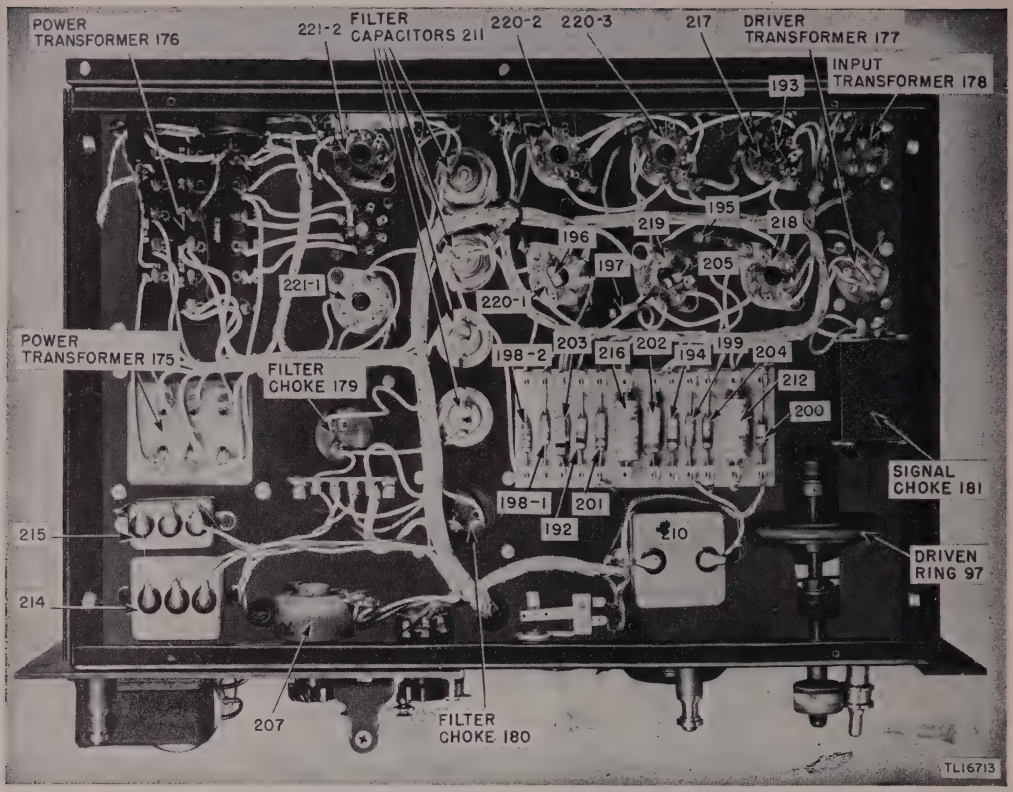


Figure 38. Bottom view of recorder with parts reference numbers.

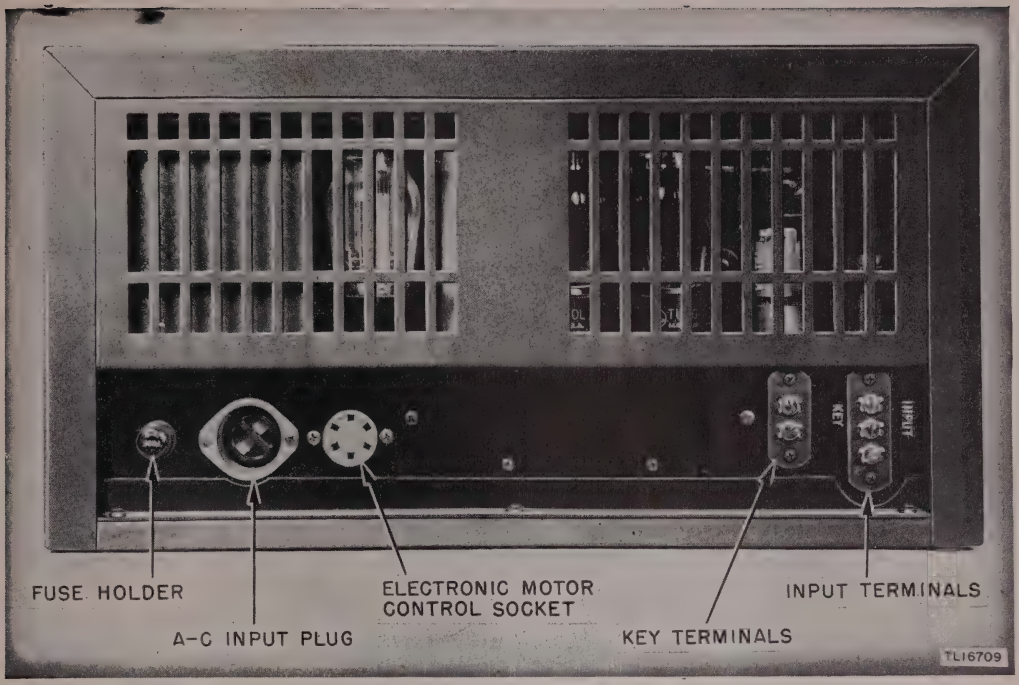


Figure 39. Rear view of recorder.

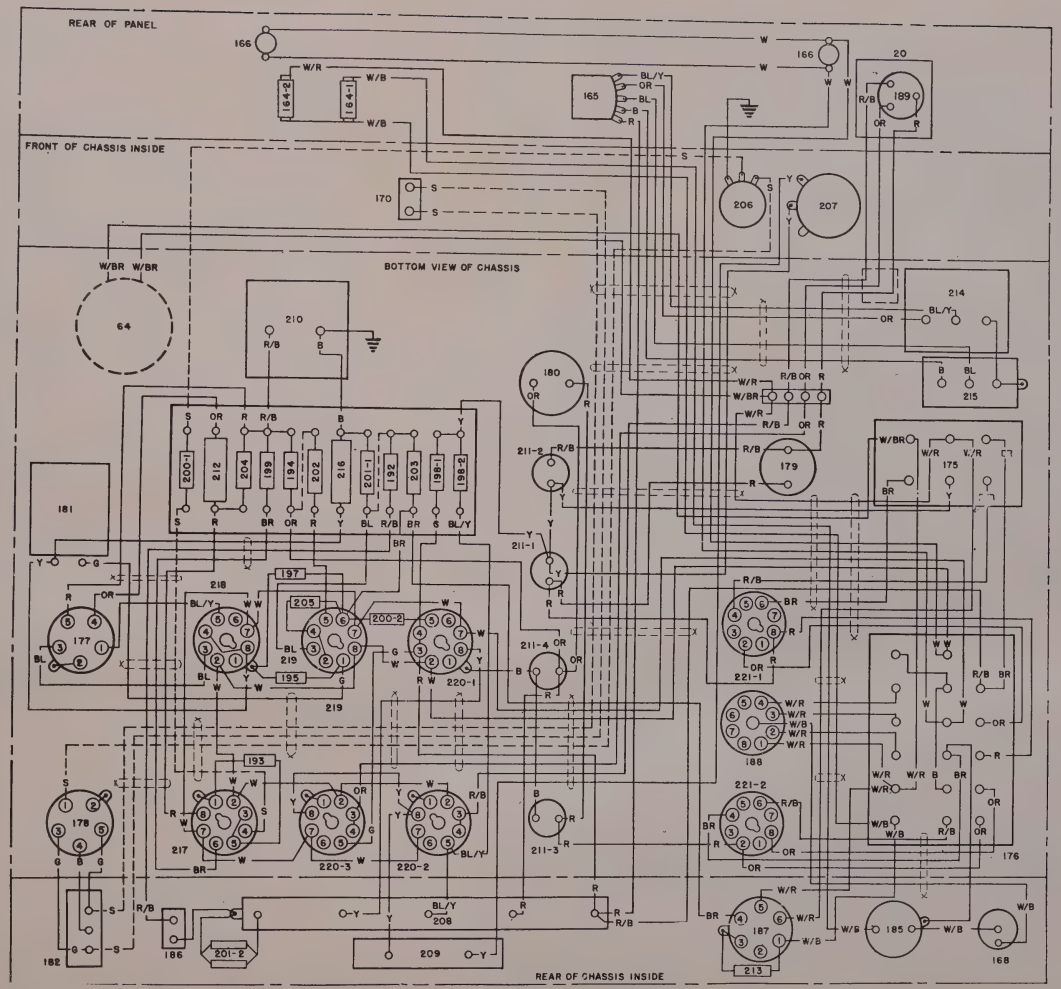
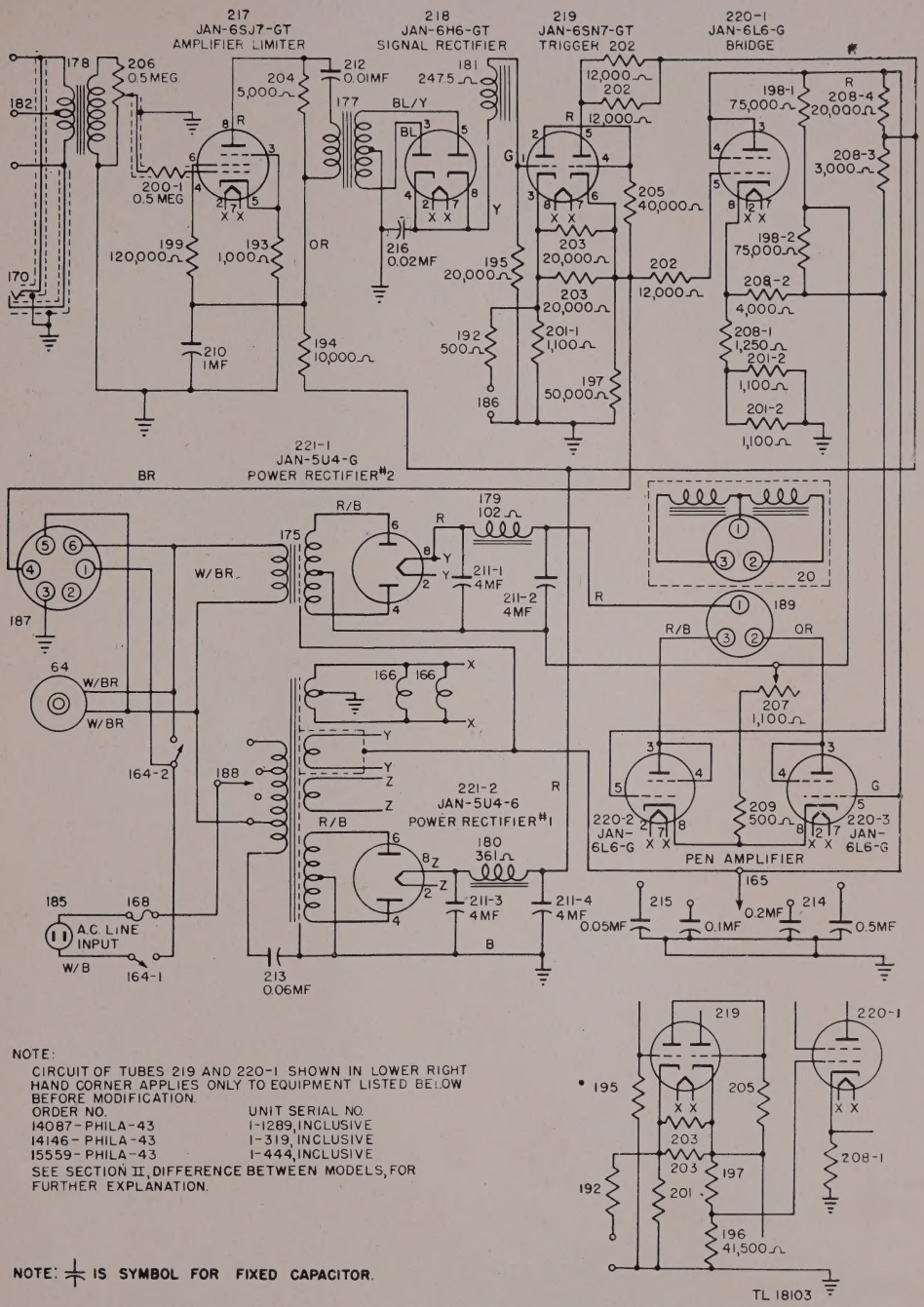


Figure 40. Recorder BC–1016, wiring diagram.



NOTE:
CIRCUIT OF TUBES 219 AND 220-1 SHOWN IN LOWER RIGHT HAND CORNER APPLIES ONLY TO EQUIPMENT LISTED BELOW BEFORE MODIFICATION.

ORDER NO.	UNIT SERIAL NO.
14087-PHILA-43	1-1289, INCLUSIVE
14146-PHILA-43	1-319, INCLUSIVE
15559-PHILA-43	1-444, INCLUSIVE

SEE SECTION II, DIFFERENCE BETWEEN MODELS, FOR FURTHER EXPLANATION.

NOTE: ⊣⊢ IS SYMBOL FOR FIXED CAPACITOR.

Figure 41. Recorder BC-1016, circuit schematic.

U. S. GOVERNMENT PRINTING OFFICE: 1947